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Survey of Viability of Indigenous Grasses, Forbs, and shrubs: Techniques of I Initial Acquisition and Treatment for Propagation in Preparation for Future Land Reclamation in the Fort Union Basin

SURVEY OF VIABILITY OF INDIGENOUS GRASSES, FORBS, AND SHRUBS: TECHNIQUES OF INITIAL ACQUISITION AND TREATMENT FOR PROPAGATION IN PREPARATION FOR FUTURE LAND RECLAMATION IN THE FORT UNION BASIN

FINAL REPORT

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Abstract

Survey of the Viability of Indigenous Grasses, Forbs, and Shrubs: Techniques of Initial Acquisition and Treatment for Propagation in Preparation for Future Land Reclamation in the Fort Union Basin

Seed maturation phenology was collected on 25 indigenous species. Seed collections were made from 219 species along with pertinent information on methods. Germination research on 46 species is essentially complete. Seed production and fill data was obtained on 35 important species. Cuttings were taken from two grasses and seven shrubs and vegetative propagation potential evaluated. Seed production in 1976 was reduced below that of 1975 and broad areas existed where no natural seed were produced. The majority of species appear to germinate readily under cool temperatures although 21 species were found to have significant dormancy characteristics. Most species exhibit after ripening such that year old seed shows higher germination percentage and often a faster germination rate. Mechanical scarification (sand) has proven best for species with hard seed coats, especially in the legumes. Fall cuttings produced viable tublings in less than half the species examined.

Survey of Viability of Indigenous Grasses, Forbs, and Shrubs: Techniques of Initial Acquisition and Treatment for Propagation in Preparation for Future Land Reclamation in the Fort Union Basin

The major research objectives of the project on regeneration characteristics of indigenous plant species of the Fort Union Basin were designed to obtain basic information on seed production, collection, handling, germination and on seedling establishment. Additionally, regeneration through cuttings and sprigs was examined for some species which produce small amounts of seed and for those species determined to possess dormancy problems which limit the use of seed for reestablishment. The ultimate objective was to secure information which would improve significantly the probability of success in establishment of indigenous species on disturbed sites and to shorten the time period in which some degree of stability can be achieved by these disrupted ecosystems.

The primary objectives of the project are to:

1. Examine and inventory natural seed maturation and production characteristics of indigenous plant species;
2. Determine optimum seed collection, handling and storage procedures;
3. Determine physical and chemical requirements for breaking seed dormancy;
4. Determine seed germination characteristics under controlled conditions;
5. Examine vegetative propagation characteristics.

Secondary objectives were to:

1. Evaluate germination, seedling establishment, and seed production characteristics on small plots on disturbed sites in the Fort Union Basin and at Missoula.

2. Evaluate transplanting procedures for seedlings and cuttings.

First and second year objectives were much the same except that new species were to be examined and adequate amounts of seed were to be collected for small plot establishment.

In summary, the objective was to research:

1. Natural seedling establishment;
2. Phenology of seed maturation;
3. Seed production under natural conditions;
4. Seed collection, and handling methods;
5. Seed fill and viability;
6. Physical and chemical requirements for breaking seed dormancy;
7. Seedling vigor under controlled conditions; and
8. Vegetative propagation methods.

Seed characteristics of 40 species or more were to be examined by the end of the second year.

Progress to Date

Field work began in June, 1976, and continued through mid-November. Laboratory work was continuous from June, 1976, to May 31, 1977. The principal investigator spent twenty-four weeks on the project from June 1, 1976 through December 31, 1976. Effort during the 1977 part of the funding year was only limited part-time due to a full teaching load at the University.

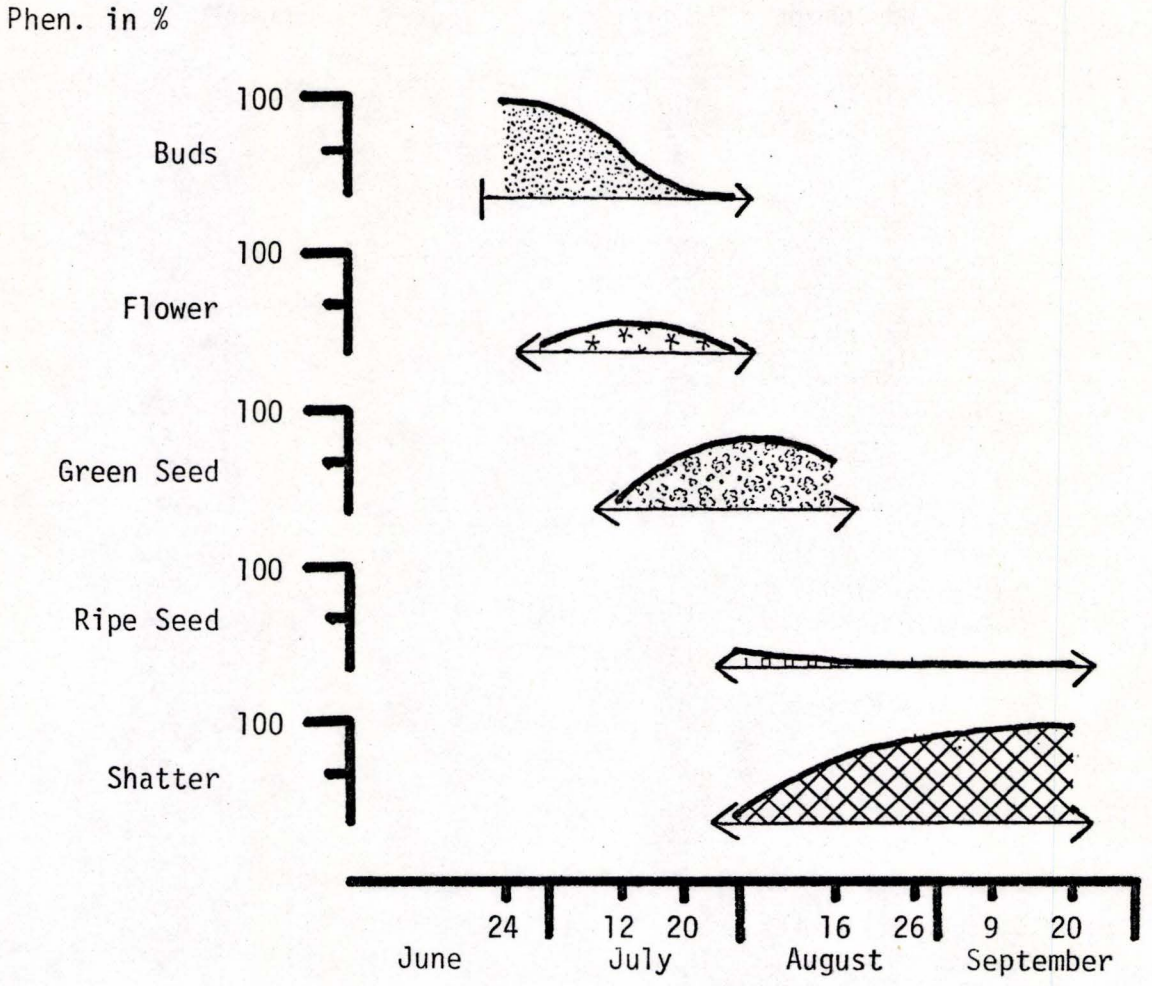
1. Natural seedling establishment. This phase was begun in 1975-1976, but problems with seedling identification forced the cessation until seedling keys could be developed. The seedling keys and reference specimens have been mostly completed from our germination work. Examiniation of several sites was made in April of 1977.

2. Phenology of seed maturation. Collection of data on phenology was begun in June of 1976 and terminated November 10, 1976. Phenological information was collected on 25 species in 1976. This data plus that of 1975 as well as seed collection dates gives seed maturation and dispersal phenology information on many species.

Problems with overlap of flowering, green seed and shatter loss with mature seed are common. Phenology of Petalostemon candidum in 1976 illustrates a species for which mature seed are a minor component of the reproductive structure at any one time. In this species, flower buds are still present on the inflorescence when seed shatter begins (Fig. 1).

Koeleria cristata is a species in which seed shatter begins when all seeds have matured. Collection of seed of this latter species is limited to a one-week period to avoid high losses to shatter. In 1976 this was the third week in July (Fig. 2).

Fig. 1. Pheonology of Petalostemon candidum 1976



In Chrysothamnus nauseosus seed shatter begins slightly before complete seed maturation; however, sizeable percentages of mature seed were available the last three weeks in October of 1976 (Fig. 3).

Both Ratibida columnifera and Echinacea angustifolia seed heads mature before shatter becomes a problem (Figs. 4, 5). Each has a long period in which seed collection can be made; Ratibida from 4-6 weeks and Echinacea several months. Although Echinacea seed were mature in September, seed extraction from heads collected before shatter had begun caused considerable damage. Seed heads collected in late October were easily handled for seed extraction with no damage. Shatter under natural conditions in Echinacea is a very slow process as some seed can be found in heads of year-old standing plants.

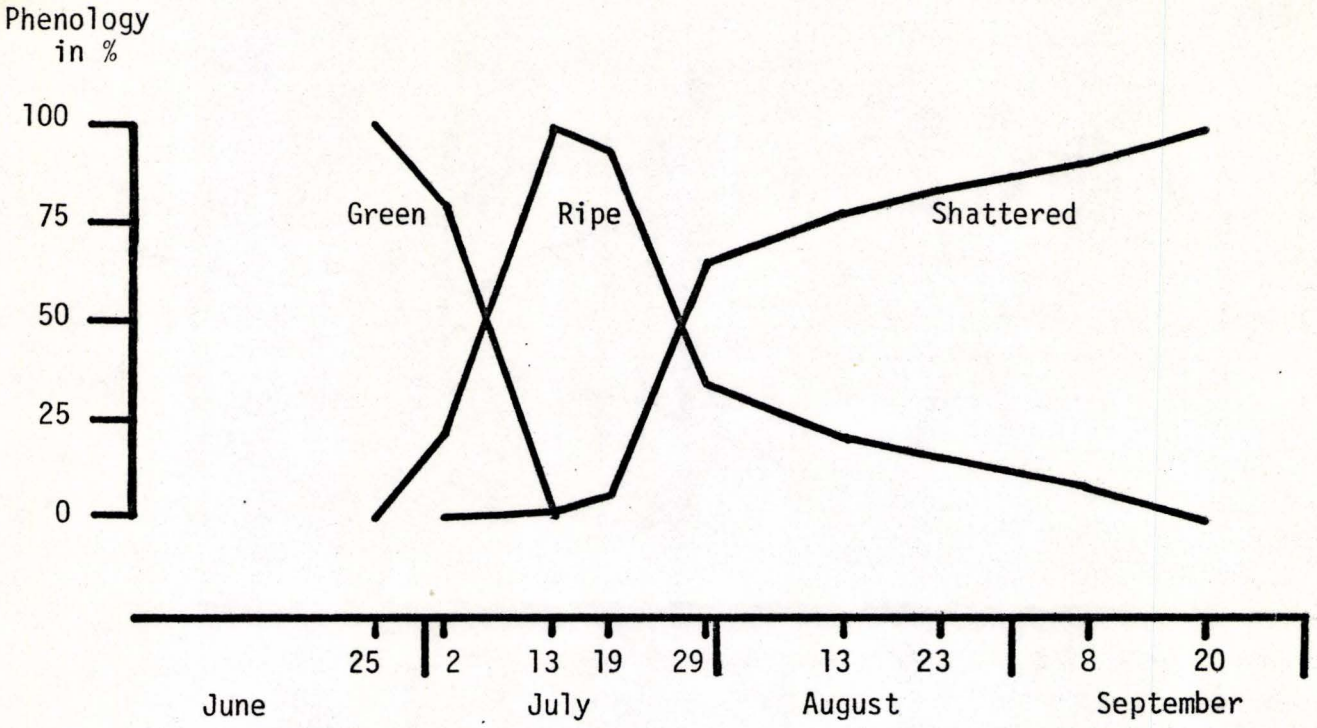


Fig. 2. Seed maturation phenology of Koeleria cristata in 1976.

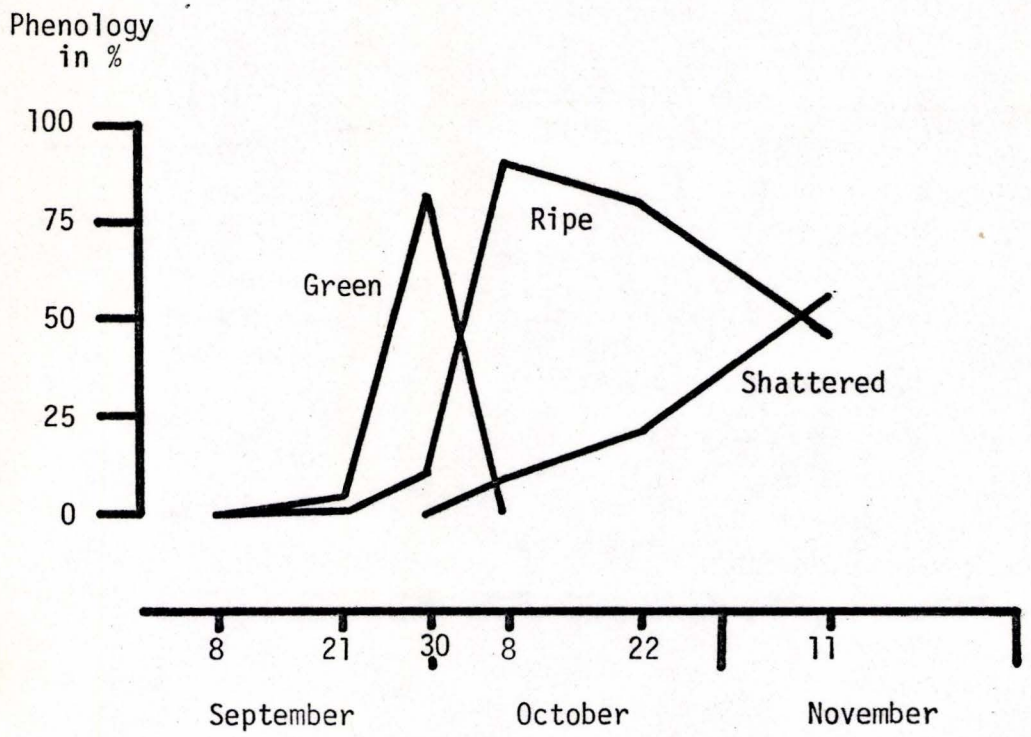


Fig. 3. Seed maturation phenology of Chrysothamnus nauseosus in 1976.

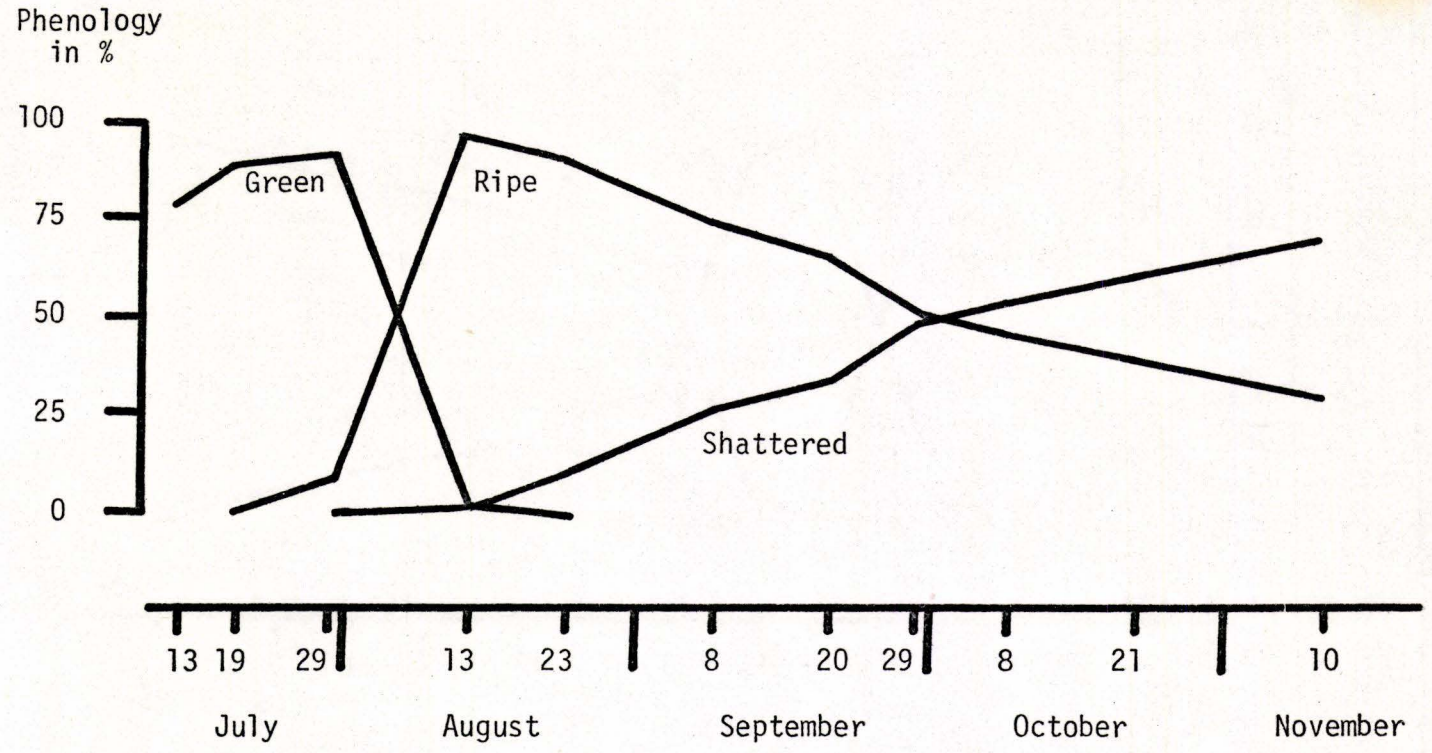


Fig. 4. Seed maturation phenology of Ratibida columnifera in 1976.

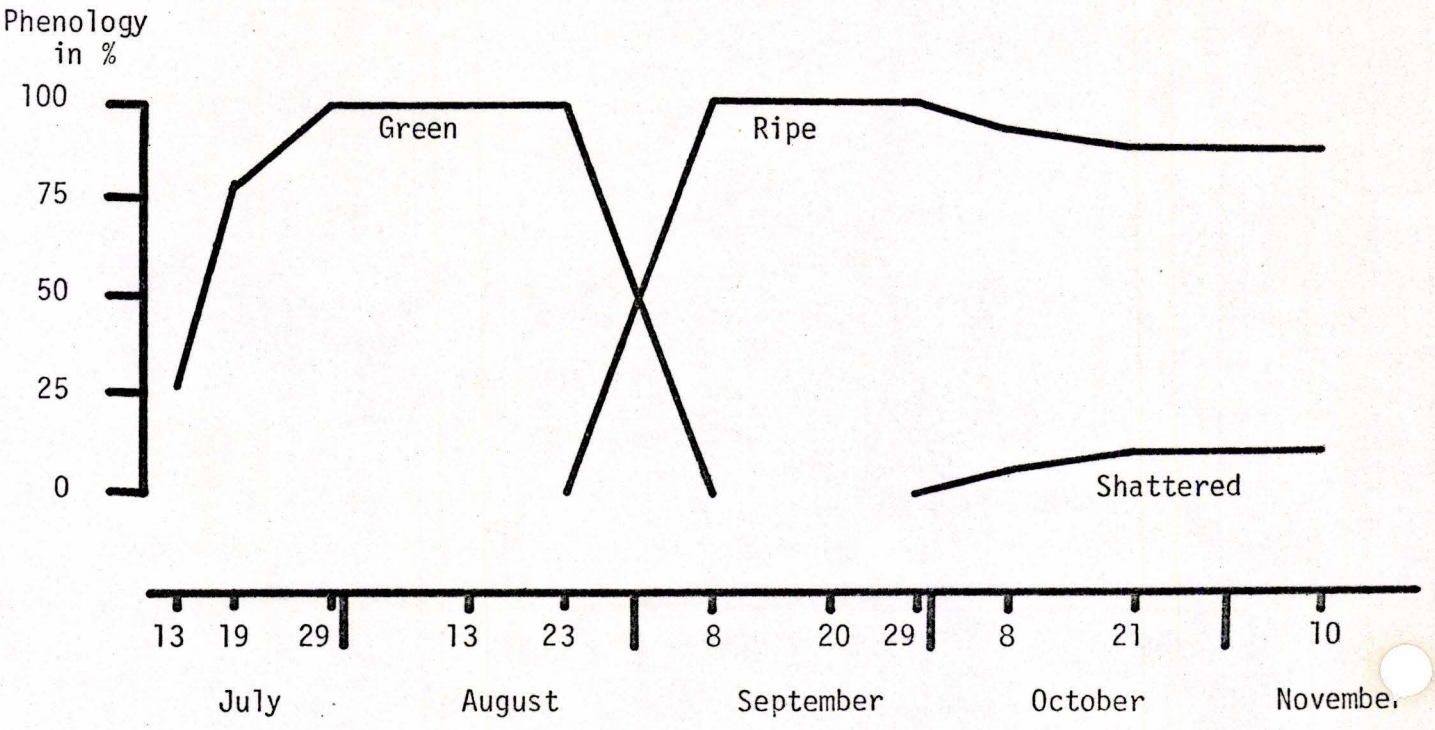


Fig. 5. Seed maturation phenology of Echinacea angustifolia in 197y.
1976

3. Seed production under natural conditions. During the 1976 field season, collections were made to determine seed production of individual plants and individual inflorescences on each plant. Data was obtained from 15 grasses, 16 forbs and 4 shrubs (Table 1).

Examination of averages shows a sharp reduction from 1975 in seed per inflorescence although seed weight is much higher. For example, one accession of Agropyron spicatum dropped from a mean of 4.9 seeds per inflorescence in 1975 to 2.0 in 1976. However, seed weight nearly doubled, dropping from 685 seed per gram to 385. Should this be a general rule, and accepting the general principle that the most vigorous seedlings come from the heavier seed, then a reduction in seed production may not represent a poor following year for seedling establishment.

Table 1 SPECIES FROM WHICH INDIVIDUAL PLANT SEED COLLECTIONS WERE MADE IN 1976.

Grasses

Agropyron smithii
Agropyron spicatum
Andropogon gerardii
Bouteloua curtipendula
Elymus canadensis
Elymus cinereus
Festuca idahoensis
Koeleria cristata
Poa juncifolia
Poa sandbergii
Puccinellia airoides
Schizachyrium scoparium
Stipa comata
Stipa spartea
Stipa viridula

Forbs

Achillea millefolium
Anemone cylindrica
Astragalus plattensis
Astragalus bisulcatus
Astragalus drummondii
Echinaceae angustifolia
Helianthus rigidus
Liatris punctata
Monarda fistulosa
Orthocarpus luteus
Penstemon glaber
Petalostemon candidum
Petalostemon purpureum
Ratibida columnifera
Solodago mollis
Solodago rigida

Shrubs

Amorpha canescens
Artemisia frigida
Atriplex nuttallii
Ceratoides lanata

4. Seed Collection, Methods and Handling

Seed collections were made from 219 plant species of the Fort Union Basin in 1976, including 51 grasses, 133 forbs, and 35 shrubs (Table 2). For the majority of species, sufficient seed were collected to test for germination characteristics. Sufficient seed was collected for many species to carry out seedling vigor studies and begin small plot work which is to begin in 1977.

Collection of indigenous plant seed was concentrated in an area south and east from Colstrip, Montana (Fig. 6) . Since 1976 was a poor seed year for many species, the search for seed was expanded to locate suitable quantities. No seed was produced on some rather sizable areas.

The process used on the majority of species in 1976 was to clip the heads off with electric shears, air dry in large paper bags, run through a head thresher, followed by screen separation in a clipper mill and a final cleaning in a seed blower. A mechanical flail was used on some species to remove appendages and in some cases to remove seed from the seed head. A vacuum cleaner was utilized on some species for which seed was on or near the ground surface such as Buchloe dactyloides, Hedysarum boreale, and Atriplex confertifolia. Very little seed damage occurred using the above processes.

Seed storage this year has been under cool dry conditions and in the laboratory. Germination has been enhanced by cool (4°C) dry storage over winter for some species collected in 1975.

Table 2 SEED COLLECTION FROM INDIGENOUS[+] SPECIES IN THE FORT UNION BASIN

1975 Grasses	No. of Accessions
Agropyron dasystachyum	0*
Agropyron smithii	4
Agropyron spicatum	7
Andropogon gerardii	2
Andropogon hallii	0
Bouteloua curtipendula	5
Bouteloua gracilis	0
Buchloë dactyloides	2
Calamagrostis montanensis	0
Calmovilfa longifolia	0
Distichlis stricta	1
Elymus canadensis	2
Elymus cinereus	1
Festuca idahoensis	0
Koeleria cristata	1
Muhlenbergia cuspidata	1
Oryzopsis hymenoides	6
Panicum virgatum	1
Poa juncifolia	2
Poa sandbergii	0
Puccinellia airoides	1
Schedonnardus paniculatus	3
Schizachyrium scoparium	5
Sitanion hystrix	3
Spartina pectinata	1
Sporobolus airoides	1
Sporobolus cryptandrus	1
Stipa comata	7
Stipa viridula	9

1976 Grasses	No. of Accessions
Agropyron dasystachyum	1
Agropyron smithii	5
Agropyron spicatum	11
Andropogon gerardii	6
Andropogon hallii	4
Aristida longiseta	3
Aristida fendleriana	1
Beckmannia syzigachne	2
Bouteloua gracilis	2
Bouteloua curtipendula	4
Bromus anomalous	2
+Bromus japonicus	1
Bromus marginatus	1
+Bromus tectorum	1
Buchloë dactyloides	4
Calamagrostis canadensis	1
Calamovilfa longifolia	3
Cinna latifolia	1
Danthonia spicata	2
Elymus canadensis	4
Elymus cinereus	10
Elymus glaucus	2
+Festuca elatior	1
Festuca idahoensis	7
Glyceria elata	2
Glyceria striata	4
Koeleria cristata	6
Muhlenbergia asperifolia	2
Muhlenbergia cuspidata	8
Muhlenbergia racemosa	1
Munroa squarrosa	4
Panicum capillare	3
Panicum virgatum	9
Phlaris arundinacea	2
Poa juncifolia	7
Poa palustris	1
Poa sandbergii	5
Puccinellia airoides	8
Schedonnardus paniculatus	1
Schizachne purpurasens	1
Schizachyrium scoparium	5
Sitanion hystrix	2
Sphenopholis obtusata	5

\+ Seed from some species not indigenous were also collected.
* 0--insufficient seed collected for germination trials.

Table 2 Continued

1975	1976	
	Grasses	No. of Accessions
	Spartina gracilis	2
	Spartina pectinata	3
	Sporobolus airoides	4
	Sporobolus cryptandrus	4
	Stipa columbiana	1
	Stipa comata	5
	Stipa spartea	3
	Stipa viridula	3

Table 2 Continued

SEED COLLECTION FROM INDIGENOUS SPECIES IN THE FORT UNION BASIN

1975

Forbs	No. of Accessions
Astragalus bisulcatus	1
Astragalus crassicarpus	4
Astragalus striatus	5
Balsamorhiza sagittata	1
Calachortus nuttallii	1
Campanula rotundifolia	0
Cleome serrulata	1
Dalea enneandra	1
Echinacea angustifolia	6
Eriogonum annuum	1
Eriogonum multiceps	0
Gaillardia aristata	0
Guara coccinea	0
Hedeoma drummondii	1
Hedysarum boreale	2
Helianthus rigidus	2
Liatris punctata	2
Linum perenne	6
Linum rigidum	2
+Medicago lupulina	0
Mentzelia decapetala	1
Monarda fistulosa	1
Oenothera caespitosa	0
Opuntia polycantha	1
Oxytropis lambertii	1
Penstemon glaber	2
Perideridia gairdneri	1
Petalostemon candidum	5
Petalostemon purpureum	4
Polygala alba	0
Potentilla glandulosa	1
Psoralea argophyla	7
Psoralea esculenta	6
Psoralea tenuiflora	1
Ratibida columnifera	5
Rumex crispus	1
Thermopsis rhombifolia	2
Vicia americana	2

Forbs	No. of Accessions
Achillea millefolium	3
Agastache anethiodora	2
Agrimonia striata	1
Anemone cylindrica	4
Antennaria neglecta	1
Apocynum androsaemilfolium	1
Apocynum cannabinum	1
Arnica sororia	2
Artemisia dracunculoides	4
Artemisia ludoviciana	4
Asclepius pumila	1
Asclepius viridiflora	3
Aster falcatus	3
Aster tanacetifolia	1
Astragalus	17
Astragalus bisulcatus	5
Astragalus crassicarpus	10
Astragalus dasyglottis	1
Astragalus drummondii	4
Astragalus gilviflorus	2
Astragalus inflexus	1
Astragalus lotiflorus	1
Astragalus miser	6
Astragalus spatulatus	1
Astragalus striatus	11
Atriplex argentea	2
Atriplex diocia	3
Bahia oppositifolia	2
Balsamorhiza sagittata	1
Campanula rotundifolia	4
Castilleja sessiliflora	5
Chenopodium botrys	1
Chrysopsis villosa	4
Cicuta douglasii	1
Cirsium undulatum	2
Clematis ligusticifolia	3
Cleome serrulata	4
+Coronilla varia	1
Crepis acuminata	1
Cryptanthe bradburiana	2
Dalea enneandra	2
Echinacea angustifolia	4
Eriogonum annuum	4

Table 2 Continued

1975	1976 Forbs	No. of Accessions
	Eriogonum caespitosum	1
	Eriogonum umbellatum	1
	Euphorbia glyptosperma	1
	Euphorbia marginata	1
	Gaillardia aristata	5
	Gaura coccinea	6
	Gaura parviflora	7
	Geum triflorum	2
	Geum macrophyllum	1
	Glycyrrhiza lepidota	2
	Grindelia squarrosa	2
	Haplopappus spinulosus	2
	Hedeoma drummondii	4
	Helianthus maxmilianii	4
	Helianthus rigidus	8
	Hedysarum boreale	2
	Heuchera richardsonii	3
+	Hypericum perforatum	1
	Iva xanthifolia	2
	Kuhnia eupatorioides	5
	Lactuca pulchella	1
	Liatris punctata	10
	Linum perenne	6
	Linum rigidum	5
	Lithospermum incisum	1
	Lotus purshianus	2
	Lupinus argenteus	6
	Lycopus americanus	1
	Lygodesmia juncea	2
	Lysimachia ciliata	1
	Mentha arvensis	2
	Mentzelia decapetala	5
	Mentzelia laevicaulis	2
	Microseris nigrescens	1
	Monarda fistulosa	5
	Moldavica parviflora	1
	Oenothera biennis	3
	Oenothera nuttallii	3
	Opuntia polycantha	1
	Orthocarpus luteus	3
	Osmorhiza chilensis	1
	Oxytropis lambertii	2
	Oxytropis sericea	5
	Penstemon eriantherus	1
	Penstemon glaber	4
	Penstemon nitidus	1

Table 2 Continued

1975	1976	
	Forbs	No. of Accessions
	Petalostemon candidum	6
	Petalostemon purpureum	10
	Phacelia hastata	1
	Phacelia linearis	2
	Physalis heterophylla	1
	Physalis lanceolata	1
	Plantago purshii	2
	Polansia trachysperma	1
	Potentilla glandulosa	2
	Potentilla gracilis	1
	+Potentilla recta	1
	Psoralea argophylla	4
	Psoralea esculenta	2
	Psoralea lanceolata	1
	Psoralea tenuiflora	4
	Ratibita columnifera	7
	Rudbeckia laciniata	1
	Rumex crispus	1
	Rumex obtusifolius	1
	Rumex salicifolius	1
	Salvia sylvestris	1
	Salvia reflexa	1
	Saponaria vaccaria	1
	Scrophularia lanceolata	1
	Sisyrinchium montanum	2
	Solanum rostratum	1
	Solidago canadensis	2
	Solidago gigantea	0
	Solidago missouriensis	5
	Solidago mollis	4
	Solidago rigida	5
	Sphaeralcea coccinea	1
	Swainsonia salusula	1
	Thalictrum dosycarpum	4
	Thermopsis rhombifolia	2
	Tragapogon dubius	1
	Triodonis leptocarpa	3
	Triglochin maritima	1
	Verbascum blattaria	1
	Vicia americana	4
	Zigadenus venenosus	1

Table 2 Continued

1975 Shrubs, Trees	No. of Accessions
Artemisia cana	1
Artemisia dracunculoides	1
Artemisia frigida	1
Artemisia ludoviciana	1
Artemisia tridentata wyomingensis	1
Atriplex confertifolia	3
Atriplex nuttallii	2
Ceratoides lanata	1
Chrysothamnus lanceolatus	1
Chrysothamnus nauseosus	1
Crataegus	1
Fraxinus pennsylvanicus	0
Juniperus horizontalis	1
Juniperus scopulorum	1
Oenothera serrulata	2
Prunus americana	1
Rhus trilobata	5
Sarcobatus vermiculatus	3
Suaeda intermedia	1
Yucca glauca	3

1976 Shrubs, Trees	No. of Accessions
Acer negundo	2
Amorpha canescens	7
Artemisia cana	6
Artemisia frigida	6
Artemisia longifolia	1
Artemisia longiloba	1
Artemisia tridentata wyomingensis	6
Atriplex canescens	6
Atriplex confertifolia	7
Atriplex nuttallii	8
Ceratoides lanata	4
Chrysothamnus nauseosus	5
Chrysothamnus viciduflorus	3
Crataegus columbiana	3
Fraxinus pennsylvanica	1
Gutierrezia sarothrae	3
Juniperus horizontalis	3
Juniperus scopulorum	3
Mahonia repens	1
Oenothera serrulata	6
Prunus americana	2
Prunus virginiana	1
Rhus trilobata	5
Ribes americanum	2
Rosa acicularis	1
Rosa arkansana	3
Rosa woodsii	3
Sarcobatus vermiculatus	4
Suaeda depressa	1
Suaeda intermedia	3
Symphoricarpos albus	1
Symphoricarpos occidentalis	3
Shepherdia argentea	1
Tetradymia canescens	1
Yucca glauca	5

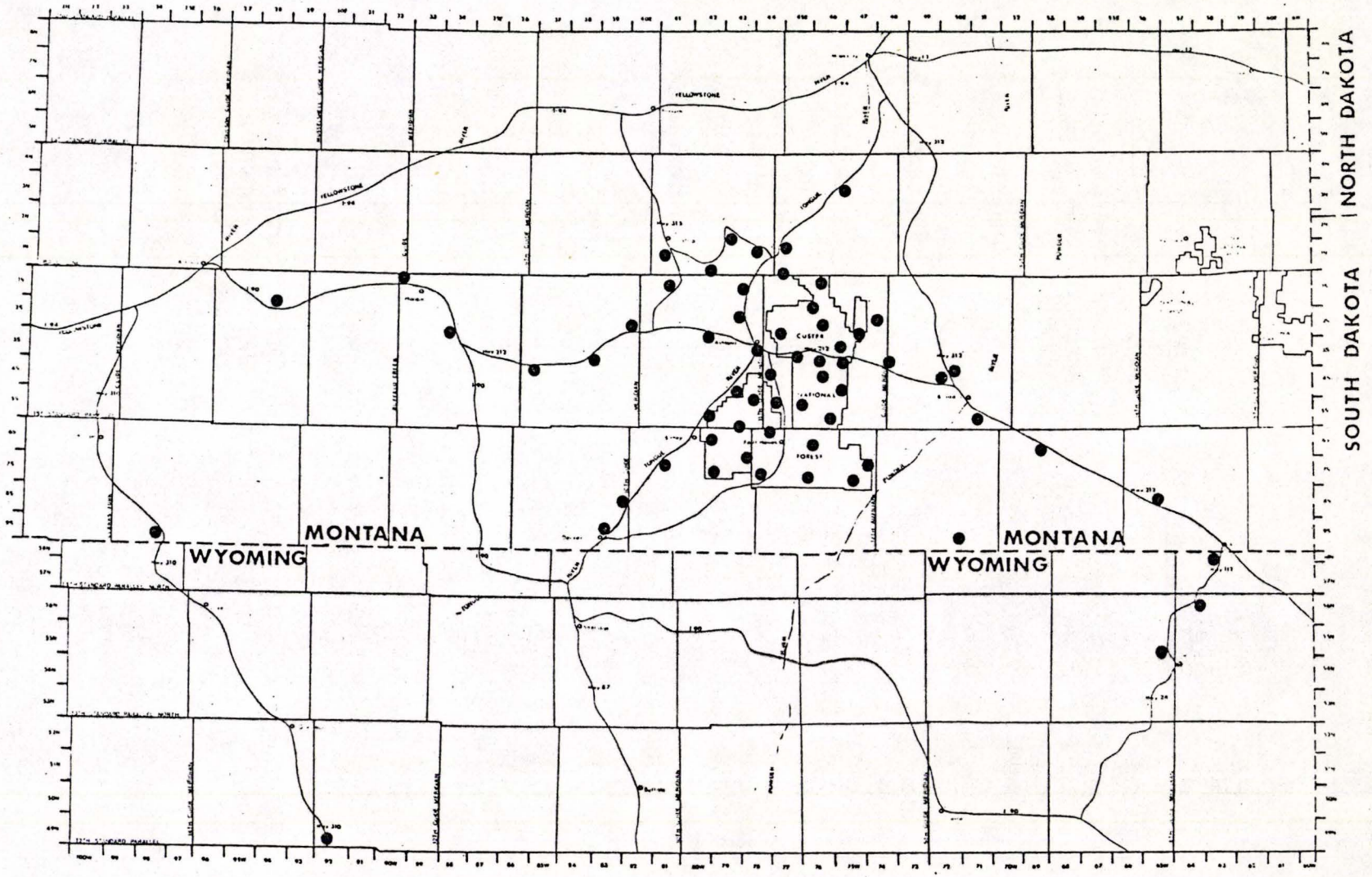


Figure 6. Location of 1976 seed collections.

5. Seed Fill and Viability

As with seed production, 15 grasses, 16 forbs, and 4 shrubs were sampled to determine seed fill (Table 1). For example, using Agropyron spicatum again on the same area as given under seed production, seed fill percentage dropped from 36 percent in 1975 to 11 percent in 1976. The percentage of empty florets increased. Average seed fill from four areas in 1975 was 40 percent and from five areas in 1976 was 25 percent. Seed fill percentages appear to be consistently lower for other upland species examined to date.

6. Physical and Chemical Requirements for Breaking Seed Dormancy

Research has been on germination response to temperature and light preceded by various storage conditions and dormancy treatments. Effort is essentially complete on 46 species (Table 3). Many other species are currently under some kind of germination test, including 21 species determined to have significant dormancy problems.

Tested species show an increase in germination after long storage, some requiring cool ($4^{o}C$) dry storage but for most, laboratory storage ($20^{o}C$) seems very suitable. Several species require long, cold ($4^{o}C$), wet stratification, others with hard seed coats appear to require a cool ($4^{o}C$) acid peat stratification, however, sand scarification has resulted in very satisfactory germination for most hard-seeded species of the pea family tested to date.

Figures 7, 8, and 9 illustrate some significant germination responses of three species. Sitanion hystrix shows a delayed response to increasingly cold temperatures but the final total germination may not be significantly different (Fig. 7).

Clemone serrulata germinates significantly better after long (3 months) cool ($4^{o}C$) wet stratification preceded by 10 or more months of $20^{o}C$ dry

storage (Fig. 8). The starting position on the vertical axis represents germination during the 3-month stratification period and is a function of seed storage length, 10 months for the high germination and 4 for the low. No germination was obtainable without cold wet stratification regardless of seed age.

Poa sandbergii illustrates some significant differences in germination percent and rate. Accession 6048 is a higher elevation collection while 6058 is the lowest elevation collection. Interaction of site and genetics may be playing a roll in creating the different germination responses.

Beginning on page 25 a summary of investigations is presented covering all pertinent information on the many species investigated.

Table 3. Grasses, Forbs and Shrubs for which germination tests are essentially complete.

Grasses

✓ Agropyron smithii
✓ Agropyron spicatum
Boutelona curtipendula
Elymus canadensis
Elymus cinereus
Koeleria cristata
Panicum virgatum
Poa juncifolia
Poa sandbergii
✓ Puccinellia aeroides
Schedonnardus paniculatus
Sitanion hystrix
Spartina pertinata
✓ Sporobolus airoides
✓ Stipa comata
✓ Stipa viridula

Forbs

Astragalus bisulcatus
Astragalus striatus
✓ Calochortus nuttallii
✓ Cleome serrulata
Dalea enneandra
Echinaceae angustifolia
Eriogonum annuum
Hedeoma drummondii
✓ Hedysarum boreale
✓ Helianthus rigidus
✓ Liatrus punctata
Linum perenne
✓ Linum rigidum
✓ Mentzelia decapetala
Monarda fistulosa
✓ Oxytropis lambertii
✓ Petalostemon candidum
Petalostemon glandulosa
Ratibida columnifera
Rumex crispus

Shrubs

Artemisia cana
Artemisia frigida
Artemisia tridentata wyomingensis
✓ Ceratoides lanata
Chrysothamnus nauseosus
Chrysothamnus vicidiflorus
✓ Oenothera serrulata
Sarcobatus vermiculatus
Yucca glauca

✓ Satisfactory germination is questionable for these species and some further tests are planned for the next three months.

Fig. 7. Germination Response of Sitanion hystrix to Temperatures.

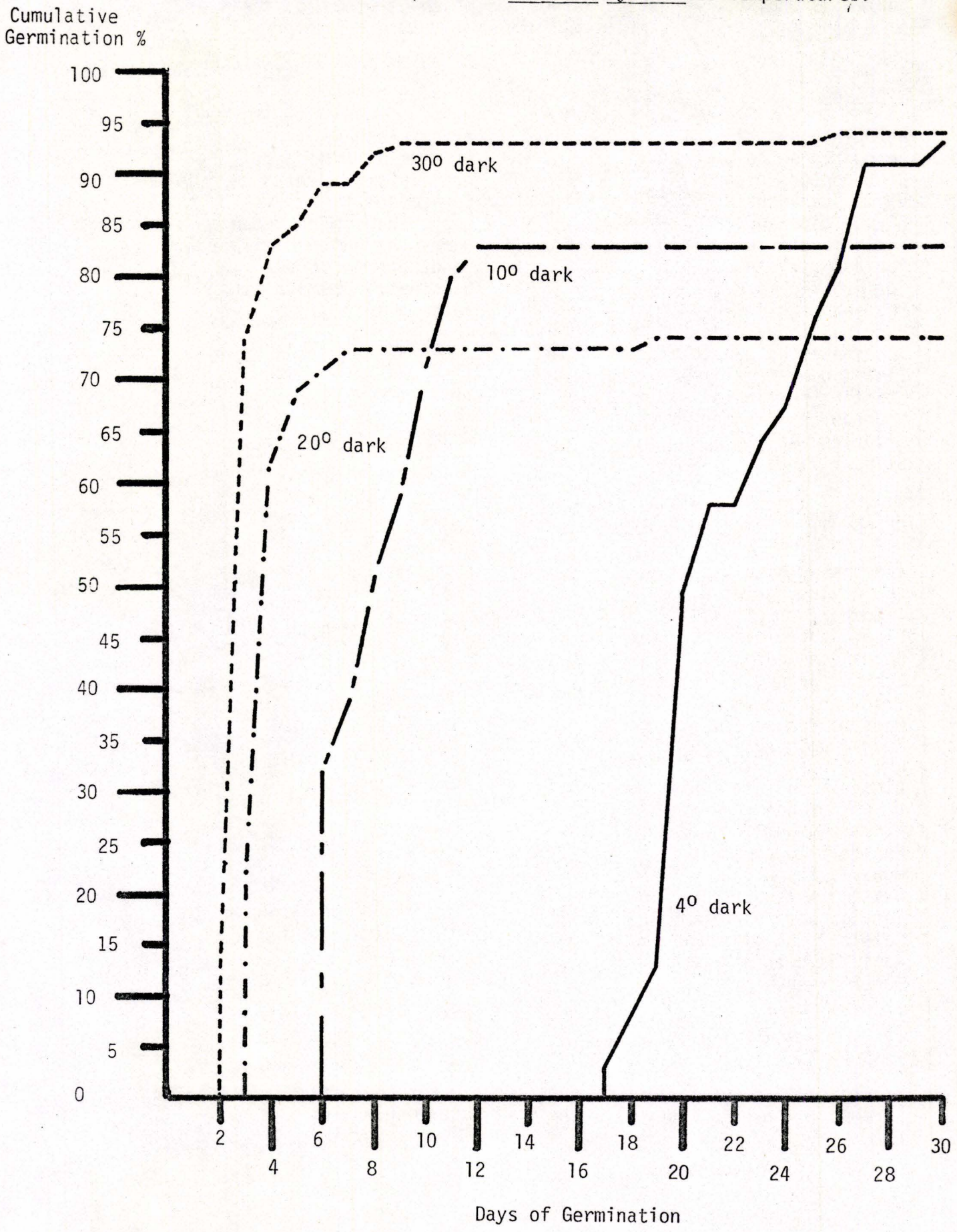


Fig. 8. Germination response of Cleome serrulata to stratification at 4°C wet.

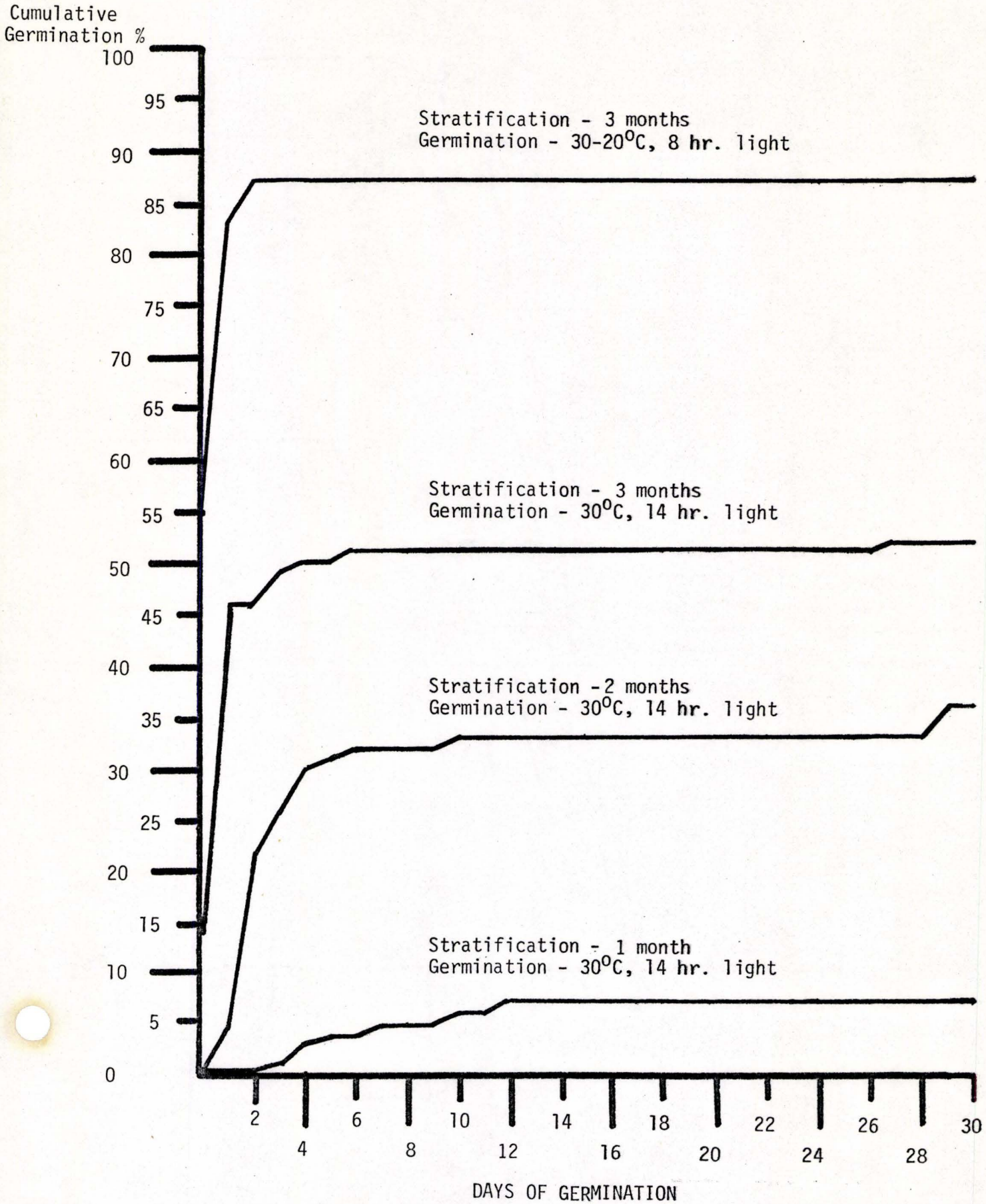
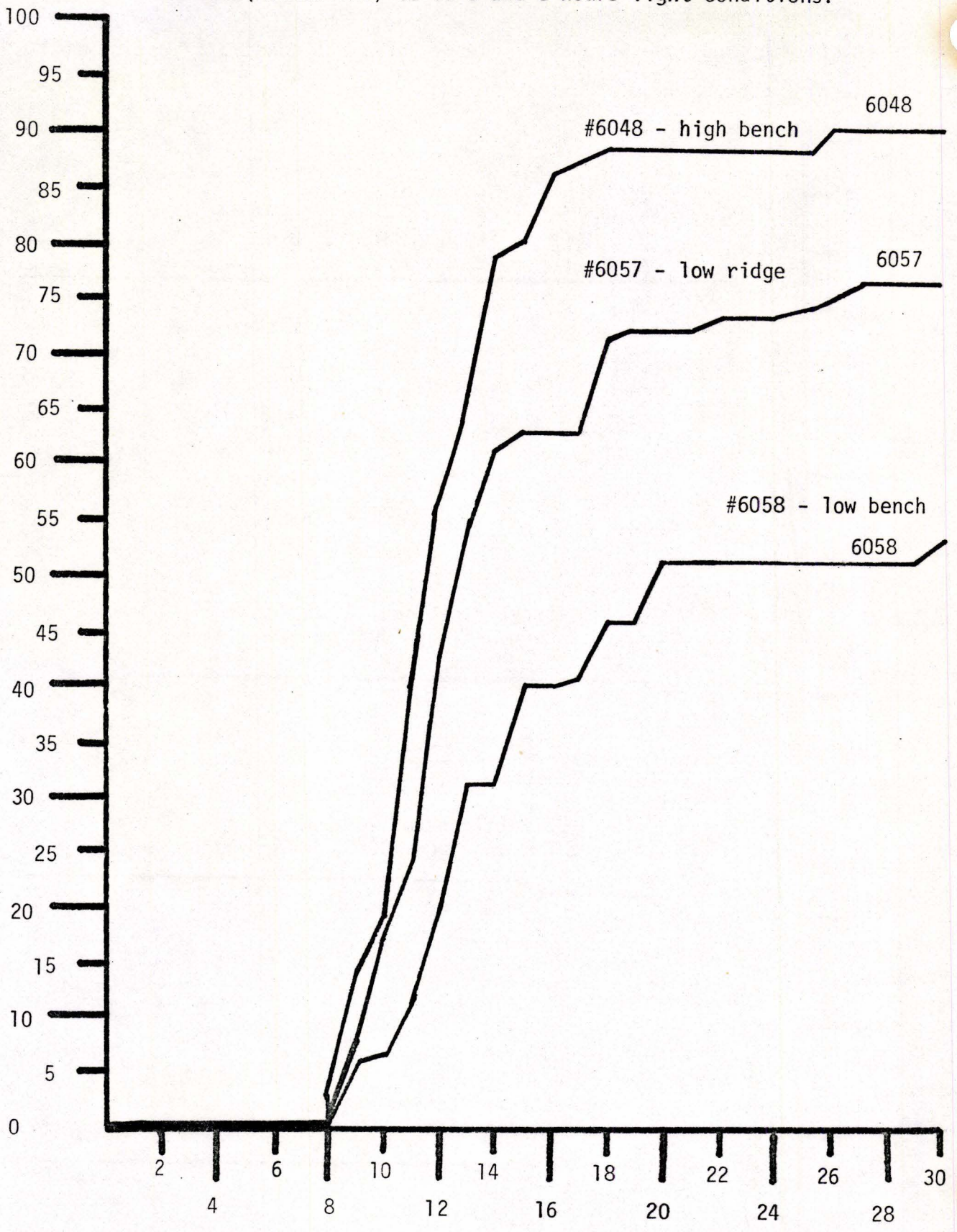


Fig. 9. Germination Response of Poa sandbergii seed collected from 3 areas (Accessions) to 10°C and 8 hours light conditions.



7. Seedling Vigor Under Controlled Conditions

This phase has only been superficially examined. General observations only have been made. Native topsoil from the Fort Union Basin was brought into Missoula the fall of 1976 and seedling growth studies have only recently been initiated on this material. Root and shoot growth rates have been examined for a few species grown in rootgrowth boxes using a standard greenhouse soil mix. The results have been unsatisfactory. New procedures utilizing native topsoil are being devised for future study.

8. Vegetative Propagation Methods

Seven shrubs and two grasses were collected in November of 1976 and various parts of the plant sectioned, dipped in a solution containing 2,000 ppm 3-Indolebutyric acid and 1,000 ppm a-Naphtahlene acetic acid, and planted in tubes containing moist standard greenhouse soil mix. Cuttings were made from rhizomes of grasses, and from new growth, old growth, and rootstalks of most shrubs. Excellent response was obtained from rhizomes of Andropogon gerardii, and from old growth of Oenothera serrulata, Rhus trilobata, and Shepherdia argententea. Limited or no response was obtained from cuttings of Calamovilfa longifolia, Acer negundo, Crataegus columbiana, Juniperus horizontalis, Prunus americana, Prunus virginiana, Rosa arkansana, and Symphoricarpos occidentalis.

Summary of Investigations

The following summary is based on 1975 and 1976 research. It is a compilation of the more significant findings on many species indigenous to southeastern Montana as to their seed phenology, collection, cleaning, storage, seed-fill, seed weight, and germination.

For collection other than hand stripping we used power shears and for some species a regular shop vacuum powered by a portable generator.

In the seed cleaning process a head thresher was used which was the ALMACO small grain plant and head thresher SV series with both spiked and rasping bar cylinder and concave. This machine worked very well for many species from which the entire inflorescense was removed.

To dewing and deawn many species a mechanical flail, i.e., Sample Seed Scarifier by Forsburg, Inc., was used very effectively although we modified it by placing a heavy screen sleeve within the drum which improved its flexibility. It was also used to depulp the fleshy seeds and worked well if followed by washing through a screen.

Many seeds were effectively cleaned with a clipper office tester and cleaner produced by Ferrell-Ross.

Air blasting where referred to was by a laboratory constructed system of compressed air moving against seed and bouncing them off a small screen. This was done on small samples only.

The seed blower, ours a Burrows Seed Blower, was the most critical piece of seed cleaning equipment. Chaff, empty seed, and light seed could all be effectively removed by the seed blower.

Seeds were placed in paper envelopes or cloth bags and stored at $20^{o}C$ dark and 25 percent relative humidity. Some species were also stored at

4^{o}C dark and 28 percent relative humidity for 8 months and some were stored in unheated metal cans at Ashland, Montana over winter.

Germination was carried out in controlled environment chambers using fluorescent light. The inclusion of incandescent light always markedly reduced germination and had a variable effect when used alone.

Seeds were placed on moist cellulose pads in covered petri dishes for germination trials. All seeds were dusted with Captan (N- [(trichloromethyl) thio] 4-Cyclohexene-1,2-dicarboximide) prior to placing them in the petri dish and seeds were watered with a dilute solution of captan (1 teaspoon per liter) when required. The use of this fungicide was essential and was the only treatment of many suggested in the literature which was effective.

Each trial consisted of 4 replications of 25 seeds randomly selected from the total lot of each accession. Germination counts were made daily for 30 days at first and then at longer intervals when germination rates were better understood.

Germination temperatures were dark 4^{o}, 10^{o}, 20^{o}, 30^{o}C and light 10^{o}, 20^{o}, 30^{o}, 20^{o}-5^{o}, 30^{o}-20^{o}C. In the latter, the cooler temperatures were during the dark period. For several species the influence of 8 and 14 hours of light was examined.

Standard stratification was at 4^{o}C on wet cellulose pads for either 1, 2, or 3 months.

Moist and dry sand was used to scarify some legume seeds. We used the sand in a mortar and ground the mixture of sand and seed with the pestal.

Within the tabled portion of the summary any blanks represent unknowns. Seed maturation and dispersal phenology is incomplete for many species.

Under item 6 procedure the numbers after clipper represent screen sizes. Seed-fill for number 8 and 9 represent fully cleaned seed, nearly all having

been processed through the seed blower.

Numbers 10 and 11 are the values from individual plant collections where available.

AGROPYRON SPICATUM

Agropyron spicatum (Pursh.) Scribn. & Smith (bluebunch wheatgrass) is a large (ours 3-6 dm tall), perennial bunchgrass found on a wide range of sites.

Flowering was completed in late June to early July in 1976, and green seed were present in the inflorescence until the peak ripe seed occurred. The shattered percentage and green seed percentage are very small, less than percent of the total when the peak in ripe seed occurred. We found the third week in July to be the better collection period, this being the first week following the peak in ripe seed.

Since the seed head is well elevated, collection by use of a head cutter was fairly easy. Cleaning was a problem due to the presence of awns. Awns were removed by 4 to 5 treatments by a mechanical flail, removing deawned florets after each treatment. Awn removal from empty and very light florets as a group was least affected by this treatment.

Optimum germination took place at 20°C on unstratified seed. New seed germinated very well at 20°C, averaging about 70 percent. Older seed germinated better than new seed when stored for several months under dry conditions. Actual storage temperature had no significant influence on germination.

Stratification reduced germination very strongly, in our trials 30 to 60 percent less than unstratified seed. Also, 10°C reduced the total and rate of germination on new seed.

From our data, fall planting of bluebunch wheatgrass would have to be early enough to allow germination to take place prior to cold weather. Planting the following spring into cool soils would appear to be the best practice.

Agropyron spicatum

PHENOLOGY

1. Ripe Seed Period	July 1 - August 30
2. Optimum Collection Period	July 7 - July 31
3. Peak Ripe Seed	July 12
4. 50% Seed Shatter	July 31

COLLECTION

5. Methods	Head cutter

CLEANING

6. Procedure	Head thresher--spike cylinder and concave Mechanical flail-30 sec-deawn Clipper-12/blank Repeat flail and clipper Seed blower
7. Seed	Floret

SEED FILL-PRODUCTION		1975	1976
8. Seed Fill - %		56	54
9. Seed Fill - Range		24-99	11-93
10. Filled Seed Per Plant		46	32
11. Filled Seed Per Inflorescence		4	3
SEED WEIGHT			
12. Grams Per Liter		192	207
13. Seed Per Gram		434	453
14. Seed Per Pound	100% PLS	252,000	141,000
	SB	197,000	206,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	5 mo.	--	20°	d	97 pls	3
20° dry	4 mo.	--	20°	8	95 pls	5
unheated	18 mo.	--	10°	8	96 pls	10
unheated	8 mo.	--	10°	14	91	5
20° dry	3 mo.	--	30-20°	8	76 pls	8

BOUTELOUA CURTIPENDULA

Bouteloua curtipendula (Michx.) Torr. (side-oats grama) is a somewhat tufted, often weakly rhizomatous (ours 3-8 dm tall), perennial grass found abundantly on gravelly and rocky uplands, sideslopes and ridges.

Flowering was completed by mid-July in 1976. Although the green seed phase overlapped the ripe seed phase, shatter did not begin until 100 percent of the seed were mature. The first 2 weeks in August was the best collection period. A majority of seed were shattered out by the first week in September.

Our collection was by hand-stripping; however, a head cutter would work well on the well-elevated inflorescence. Cleaning yields some caryopsis; however, most of the resultant material was clusters of spikelets.

Germination obtained from the caryopsis was all very high averaging about 95 percent for all treatments except when cold $10^{o}C$ germination temperatures followed the short, 1-month stratification treatment. In this latter case germination was reduced in total and rate.

Stratification neither reduced nor improved germination; however, a rather definite reduction in germination during stratification took place on older seed. For example, 5-month old seed reached as much as 57 percent germination during 2 months stratification, while the 12-month old seed reached a maximum of 11 percent germination during the same stratification period.

Our trials would indicate that immediate fall planting or planting the following year in the spring or fall are all viable planting periods for side-oats grama.

Bouteloua curtipendula

PHENOLOGY

1. Ripe Seed Period — July 13 - Sept 6
2. Optimum Collection Period — July 16 - Aug 28
3. Peak Ripe Seed — July 29
4. 50% Seed Shatter — August 28

COLLECTION

5. Methods — Hand-stripped

CLEANING

6. Procedure — Head thresher
Clipper 8/(1/25)

7. Seed — Caryopsis-spikelets

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %		
9. Seed Fill - Range		
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		

SEED WEIGHT

12. Grams Per Liter
13. Seed Per Gram
14. Seed Per Pound

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	4 mo	1 mo/4°wet	20°	14	99	2
20° dry	4 mo	1 mo/4°wet	10°	14	60	15
20° dry	12 mo	--	20-5°	14	96	3
20° dry	12 mo	1 mo/4°wet	20-5°	14	98	2
20° dry	12 mo	1 mo/4°wet	30-20°	14	95	1

DISTICHLIS STRICTA

Distichlis stricta (Torr.) Rydb. (inland saltgrass) is a strongly rhizomatous (ours 2-3 dm tall) grass found in moist saline sites. Production of pistillate inflorescences is low and irregular so that collection was possible in 1975 but not in 1976.

Collection was difficult since the seed heads are located from ground level to 3 dm. Cleaning was also a lengthy process to obtain a mixture of viable spikelets, florets and caryopses, requiring repeated milling and threshing. Due to high seed damage, leaving the seed unit as the spikelet appears desirable; however, no germination was obtained except from the caryopsis.

Stratification of older seed, 8 or more months, was required to obtain high germination. Long stratification, 3 months, followed by 20-5°C alternating temperature was best, while under shorter stratification of 1 or 2 months the warmer 30-20°C alternating temperature was best for germination. In the latter case, germination rate was about 2 times as fast as at cooler temperatures.

Our data would indicate a preference for planting caryopses from inland saltgrass in the fall of the year after harvest.

Distichlis stricta

PHENOLOGY

1. Ripe Seed Period
2. Optimum Collection Period — (Early August - Early Sept 75)
3. Peak Ripe Seed
4. 50% Seed Shatter

COLLECTION

5. Methods — Head cutter

CLEANING

6. Procedure — Mechanical flail
Clipper 9/16 x 60
Repeat flail and clipper

7. Seed — Caryopsis-floret-spikelet

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %		
9. Seed Fill - Range		
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		
SEED WEIGHT		
12. Grams Per Liter	161	
13. Seed Per Gram	433	
14. Seed Per Pound		

GERMINATION

SB 197,000

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20°dry	8 mo	3 mo/4°wet	20-5°	14	92	8
20°dry	8 mo	3 mo/4°wet	20-5°	14	43	14
20°dry	12 mo	1 mo/4°wet	30-20°	14	80	4
20°dry	12 mo	3 mo/4°wet	30-20°	14	40	4
20°dry	12 mo	--	20-5°	14	5	22

ELYMUS CANADENSIS

Elymus canadensis L. (canada wildrye) is a short-lived perennial bunchgrass of medium height (ours 6-10 dm) found on open slopes and sandy soil.

Although collection was relatively easy due to the well-elevated seed head and persistent florets, cleaning was a very significant problem because of the awns which became tangled in the mechanical deawning methods we used. The awn is very stout and tough and requires a clipping process.

Optimum treatment was 20°C dry storage for 4 to 12 months and germination at 20°C constant or 20-5°C alternating temperatures. The alternating temperature was best on older seed lots and equal to that obtained from 4-month old seed.

Cold storage temperatures strongly reduced germination to less than 50 percent of optimum. Germination was equal to optimum, however, if cold storage was followed by a long warm (12 month --20°C) storage treatment.

Stratification reduced germination except on older seed, over 8 months, which were stratified for 3 months and germinated at 20-5°C alternating temperatures. However, maximum germination under these conditions was 10 percent or more below optimum.

Canada wildrye appears to require overwinter storage at fairly warm conditions and spring planting for high germination.

Elymus canadensis

PHENOLOGY

1. Ripe Seed Period
2. Optimum Collection Period — (Early Aug - Late Aug 75-76)
3. Peak Ripe Seed
4. 50% Seed Shatter

COLLECTION

5. Methods — Head cutter

CLEANING

6. Procedure — Head thresher--spiked cylinder & concave
Clipper 12/(1/25)--awned

7. Seed — Floret

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %	87	78
9. Seed Fill - Range	61-100	61-96
10. Filled Seed Per Plant	--	--
11. Filled Seed Per Inflorescence	--	13
SEED WEIGHT		
12. Grams Per Liter	516	304
13. Seed Per Gram	287	209
14. Seed Per Pound — 100% PLS		76,700
SB	82,000	95,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20°dry	4 mo	--	20°	8	99 pls	10
20°dry	12 mo	--	20°	8	82 pls	8
4°dry	8 mo	--	10°	14	22	18
4°dry	8 mo	--	20°	14	41	8
4°dry	8 mo	--	30°	14	13	14

ELYMUS CINEREUS

Elymus cinereus Scribn. & Merr. (basin wildrye) is a very large (ours 1.8-2.2 m tall), very robust, clumped grass found in sites where moisture availability is rather high.

Seed was ripe on the various collection areas from late July on but most of it had shattered out by the middle of August. Wind usually removed all the seed within a week after they ripened at any one site. The cleaning process used removed empty florets from the seed lots rather well in the majority of cases.

Seed germinated very well if stored for 5 to 12 months at 20°C and germinated at 20°C constant or 20-5°C alternating tempeatures. The alternating temperature tended to be better for the year-old seed.

The longer stratification periods of 2 and 3 months were favorable for germination if the following germination temperatures were 20°C or less. No differences were seen in the above results between 5-month old and 12-month old seed. Percentage germination exceeded 70 in nearly all collections.

Cold dry storage reduced germination very markedly from the optimum of 90 percent or more to less than 10 percent regardless of germination temperature. Some recovery was obtained by further storage at 20°C.

Only the 30°C constant germination temperature reduced total germination, while 10°C reduced the rate of germination.

Based on these trials, basin wildrye seed should be overwintered at 20°C storage temperature and planted in early spring. Fall planting is, however, possible the first one after harvest and good germination should result.

PHENOLOGY

1. Ripe Seed Period
2. Optimum Collection Period — (Late July - Mid-Aug 75-76)
3. Peak Ripe Seed
4. 50% Seed Shatter

COLLECTION

5. Methods — Head cutter

CLEANING

6. Procedure — Head thresher--spiked cylinder & concave
Mechanical flail 30 sec.
Clipper 9/(1/25)
Seed blower
7. Seed — Florets

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %	62	93
9. Seed Fill - Range	16-85	90-97
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		
SEED WEIGHT		
12. Grams Per Liter	223	210
13. Seed Per Gram	370	404
14. Seed Per Pound		

GERMINATION — SB — 168,000 — 183,000

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20°dry	5 mo	--	20°	8	94 pls	10
20°dry	12 mo	--	20°	8	72 pls	7
20°dry	12 mo	--	10°	8	74 pls	14
20°dry	12 mo	--	30°	8	42 pls	15
20°dry	12 mo	1 mo/4°wet	20-5°	8	92 pls	1

KOELERIA CRISTATA

Koeleria cristata (L.) Pers. (prairie junegrass) is a small (ours 3-4 dm tall) perennial bunchgrass found abundantly throughout the area.

Flowering was completed by mid-June of 1976. Green seed were present on the head until mid-July at which time 100 percent ripe seed were found. Seed began to shatter out immediately after all had matured; however, most florets were intact until the end of July.

Collection and cleaning were all rather easily accomplished by the procedure recommended. Seed maturation in this species has to be based on lemma coloration, i.e., loss of green cast, and not on a hardening of the endosperm since it remained a transparent to translucent viscous liquid regardless of when collected or how long stored.

Optimum germination took place after 4 months dry 4°C or 20°C storage and a temperature of 20°C. Under light conditions, a constant germination temperature was much better than the 20-5°C alternating temperature, 86 versus 34 percent respectively for 12-month old seed. Removal of light from the 20°C constant temperature gave the maximum, 99 percent, germination.

Stratification reduced total germination from 10 to 80 percent depending on the germination temperature. Long stratification followed by 20-5°C alternating temperature yielded 72 percent germination, which was the highest from stratified seed.

Planting of prairie junegrass should be in the early spring after dry winter storage. Planting in either the first or second fall would be expected to yield a lower germination.

Koeleria cristata

PHENOLOGY

1. Ripe Seed Period	July 1 - Sept 6
2. Optimum Collection Period	July 1 - July 30
3. Peak Ripe Seed	July 13
4. 50% Seed Shatter	July 30

COLLECTION

5. Methods	Head cutter

CLEANING

6. Procedure	Head thresher--spiked cylinder and concave Clipper (1/13)/blank Seed blower
7. Seed	Floret

SEED FILL-PRODUCTION		1975	1976
8. Seed Fill - %		82	65
9. Seed Fill - Range		77-87	33-91
10. Filled Seed Per Plant		107	
11. Filled Seed Per Inflorescence		31	
SEED WEIGHT			
12. Grams Per Liter		214	209
13. Seed Per Gram		4945	4922
14. Seed Per Pound	100% PLS	2,487,000	
	SB	2,245,000	2,235,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	12 mo	--	20°	d	99 pls	5
20° dry	12 mo	--	10°	8	55	16
20° dry	12 mo	--	20°	8	86	8
20° dry	12 mo	--	30°	8	70	6
20° dry	12 mo	--	30°	d	48	15

PANICUM VIRGATUM

Panicum virgatum L. (switchgrass) is a large (ours 5-7 dm tall), weakly clumped and strongly rhizomatous grass found in moist, non-saline swales. It is infrequent but can be found in areas protected from grazing.

Collection was no problem because of the well-elevated large panicle. However, cleaning required a double hammer milling or mechanical flailing.

Optimal germination was obtained after 1 to 2 months stratification followed by 20°C constant germination temperature. Alternating temperatures were not as good. Marked reduction in germination was noted from alternating temperature preceded by more than 1 month of stratification. The warmer 30°C temperature reduced total germination while 10°C reduced germination total and rate.

Extending the stratification to 3 months followed by 10°C germination temperature increased germination to 79 percent, a sharp increase over 2-month stratification.

Cold, 4°C, dry storage for 12 months followed by 20-5°C alternating temperature yielded 79 percent germination.

Either immediate fall planting or 20°C storage over winter and spring planting appears to be good practice for switchgrass. However, since year-old seed stratified for 3 months yielded 60 percent germination, fall planting the second year is a possibility.

Panicum virgatum

PHENOLOGY

1. Ripe Seed Period
2. Optimum Collection Period — (Late Aug - Mid-Sept 75-76)
3. Peak Ripe Seed
4. 50% Seed Shatter

COLLECTION

5. Methods — Head cutter

CLEANING

6. Procedure — Head thresher--spiked cylinder and concave
   Mechanical flailing--30 sec.
   Clipper 7/(1/25)
   Repeat flail and clipper
   Seed blower
7. Seed — Floret

SEED FILL-PRODUCTION		1975	1976
8. Seed Fill - %		93	45
9. Seed Fill - Range			1-93
10. Filled Seed Per Plant			
11. Filled Seed Per Inflorescence			
SEED WEIGHT			
12. Grams Per Liter		490	302
13. Seed Per Gram		843	1079
14. Seed Per Pound	100% PLS	--	--
	SB	383,000	490,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	4 mo	2mo/4° wet	20°	14	86	6
20° dry	4 mo	2mo/4° wet	10°	14	10	24
20° dry	4 mo	2mo/4° wet	30°	14	57	4
20° dry	12 mo	1mo/4° wet	30-20°	14	74	3
20° dry	12 mo	1mo/4° wet	20-5°	14	70	8

POA JUNCIFOLIA

Poa juncifolia Scribn. (alkali bluegrass) is a small (ours 3-4 dm tall), tufted grass of the moist alkaline areas. It was locally abundant, easily collected, and easily cleaned.

Optimum germination was reached after 4 months or more storage at 20°C and germination temperatures of 20°C constant or 20-5°C alternating. After 4 months, 70 percent germination was obtainable, while after 12 months, 95 percent germination was possible.

Stratification reduced total germination on newer seed but for 12-month old seed a short 1-month stratification followed by 30-20 alternating temperature yielded 91 percent germination. One significant point is that germination during cold wet stratification increased very rapidly with seed age. For example, after 1-month stratification, germination was 0, 57, and 83 percent for seeds 6, 10, and 12 months old respectively.

Cold dry storage reduced total germination to a maximum of 29 percent.

These trials indicate that alkali bluegrass could be planted the first fall but that storage at 20°C and planting in the spring would be first preference and planting the second fall would be next in preference.

Poa juncifolia

PHENOLOGY

1. Ripe Seed Period
2. Optimum Collection Period — (Mid-July - Mid-Aug 75-76)
3. Peak Ripe Seed
4. 50% Seed Shatter

COLLECTION

5. Methods — Head cutter

CLEANING

6. Procedure — Head thresher--spiked cylinder and concave
Clipper 7/(1/25)
Seed blower

7. Seed — Floret

SEED FILL-PRODUCTION		1975	1976
8. Seed Fill - %		90	88
9. Seed Fill - Range		85-94	81-94
10. Filled Seed Per Plant			71
11. Filled Seed Per Inflorescence			14
SEED WEIGHT			
12. Grams Per Liter		326	211
13. Seed Per Gram		2255	3178
14. Seed Per Pound	100% PLS	--	1,254,000
	SB	1,024,000	1,443,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	12 mo	--	20-5°	14	95 pls	7
20° dry	12 mo	--	10°	d	90 pls	10
20° dry	12 mo	--	4°	d	83	--
20° dry	5 mo	--	10°	d	14 pls	19
4° dry	8 mo	--	10°	14	29	17

POA SANDBERGII

Poa sandbergii Vasey (native bluegrass) is a short (ours 2-3 dm tall), tufted grass well-scattered throughout the dry uplands and slopes.

Flowering had ceased by early June in 1976. Shatter loss had begun before all seed on the head had matured and the majority of seed were lost within a week's time after completion of maturation.

Collection of seed took place near the end of the green seed phase of the inflorescence, which in 1976 was from the end of June to mid-July. Cleaning after drying of seed heads posed no problems.

Optimum germination took place at 10°C constant temperature after 4 months or more of 20°C storage. At temperatures of 30°C or 30-5°C germination was all but eliminated.

The presence of light consistently improved germination at 10°C and very markedly reduced germination at 20°C. In the latter case, for example, a reduction from 42 percent to 16 percent germination for one accession represents the magnitude of reduction.

Based on our tests, native bluegrass seed should be stored over winter at 20°C and planted very early in the spring.

Poa sandbergii

PHENOLOGY

1. Ripe Seed Period	June 15 - July 30
2. Optimum Collection Period	June 20 - July 17
3. Peak Ripe Seed	July 12
4. 50% Seed Shatter	July 17

COLLECTION

5. Methods	Head cutter

CLEANING

6. Procedure	Head thresher--spiked cylinder and concave Mechanical flail--30 sec. Clipper (1/13)/(1/25) Seed blower
7. Seed	Floret

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %	61	78
9. Seed Fill - Range	--	65-90
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		

SEED WEIGHT

12. Grams Per Liter		211	223
13. Seed Per Gram		2494	2182
14. Seed Per Pound	SB	1,132,000	991,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	6 mo	--	10°	8	83 pls	12
20° dry	6 mo	--	20-05°	8	38 pls	10
20° dry	4 mo	--	10°	8	87	13
20° dry	4 mo	--	20°	8	56	9
20° dry	4 mo	--	30°	8	16	7

PUCCINELLIA AIROIDES

Puccinellia airoides (Nutt.) Wats and Coult. (nuttall alkali-grass) is a short (ours 0.8-1.5 dm tall), somewhat spreading grass found in moist alkaline sites.

Collection was a prblem in this species in that the inflorescences are elevated to various heights and loss of seed to wind shatter occurs as they mature. From 25 to 75 percent of the seed was lost in 1976 by the end of the green seed phase. Cleaning poses no problems.

Optimum germination was obtained from ripened seed germinated at 30-20°C alternating temperature after 5 months dry storage at 20°C. Older seed, 12 months, and newer seed from some accessions germinated better at 20-5°C alternating temperature. Total germination of 100 percent was obtained from one accession at the lower alternating temperature. Our data indicate the warmer germination temperature requirement was associated with seed collected while green seed are present and the colder temperature requirement was associated with collection made when all seed were mature and shatter well in progress.

Seed germinated better at 10°C constant temperature than at 20°C or 30°C and in 12-month old seed reached 60 percent under dark conditions and 49 percent with light present.

Germination after stratification reached a maximum of 1 percent with constant germination temperatures and 25 percent with alternating 30-20°C temperature.

Nuttall alkali-grass should be stored over winter at 20°C and planted in mid to late spring for best germination results.

Puccinellia airoides

PHENOLOGY

1. Ripe Seed Period
2. Optimum Collection Period — (Mid-July - Mid-Aug 75-76)
3. Peak Ripe Seed
4. 50% Seed Shatter

COLLECTION

5. Methods — Head cutter

CLEANING

6. Procedure — Head thresher--spiked cylinder and concave
   Clipper (1/13)/6x60
   Seed blower

7. Seed — Floret

SEED FILL-PRODUCTION		1975	1976
8. Seed Fill - %		83	99
9. Seed Fill - Range		77-95	97-100
10. Filled Seed Per Plant			356
11. Filled Seed Per Inflorescence			21
SEED WEIGHT			
12. Grams Per Liter		464	502
13. Seed Per Gram		4948	5156
14. Seed Per Pound	100% PLS		2,097,000
	SB	2,246,000	2,341,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	5 mo	--	30-20°	8	98	8
20° dry	5 mo	--	20-05°	8	1	--
20° dry	5 mo	--	30°	8	0	--
20° dry	5 mo	--	10°	d	10	10
20° dry	5 mo	--	10°	8	13	12

SCHEDONNARDUS PANICULATUS

Schedonnardus paniculatus (Nutt.) Trel. (tumblegrass) is a spreading to prostrate (ours up to 2 dm tall), short-lived perennial grass found on alluvial fans in localized colonies.

Collection was a problem as a rake was needed to collect the entire strongly curved flowering culms just prior to its separation from the crown and just after seed maturity. About a week's time was available for collection, otherwise plants were windblown from the area. Cleaning is also a problem in that it is a lengthy process.

Optimum germination was obtained only by 3-month stratification followed by 20-5°C alternating temperature. Seeds not stratified or stratified and germinated at any other temperature germinated very poorly. Constant 10°C, 30°C, and alternating 30-20°C temperatures yielded germination percentages of 2 to 29 percent.

Immediate fall planting of tumblegrass appears to be the best practice with perhaps fall planting a year later as a poor second choice. Very early spring planting into cold soil may be better than a delay until fall.

Schedonnardus paniculatus

PHENOLOGY

1. Ripe Seed Period

2. Optimum Collection Period — (Late July - Early Aug 75-76)

3. Peak Ripe Seed

4. 50% Seed Shatter

COLLECTION

5. Methods — Raked

CLEANING

6. Procedure — Mechanical flail w/ screen--30 sec.
Clipper (1/15)/blank
Repeat mechanical flail
and clipper threshing
Seed blower

7. Seed — Spikelet

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %	98	98
9. Seed Fill - Range	97-99	97-99
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		
SEED WEIGHT		
12. Grams Per Liter	515	432
13. Seed Per Gram	2925	2389
14. Seed Per Pound SB	1,328,000	1,085,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	8 mo	3mo/4°wet	20-5°	14	80	6
20° dry	12 mo	3mo/4°wet	30-20°	14	29	4
20° dry	8 mo	--	20-5°	14	11	15
20° dry	6 mo	1mo/4°wet	20°	14	40	5
20° dry	6 mo	1mo/4°wet	20-5°	14	37	10

SITANION HYSTRIX

Sitanion hystrix (Nutt.) J.G. Smith (squirreltail) is a short (ours 2-3 dm tall), somewhat spreading short-lived perennial bunchgrass. It was found locally abundant on disturbed sites as well as scattered throughout the grasslands.

Collecting the seed of squirreltail was very difficult due to the mixed elevation of seed heads, the long stout tangled awns, and the tendency for the entire seed head to disarticulate and blow away immediately after seed maturity. A large vacuum would probably work well, although the intake hose should have a 3-inch or more inside diameter. We had limited success with a 2.25-inch inside diameter hose.

Cleaning requires a deawner, although some success can be expected with a hammer mill or mechanical flail. Seeds had to be completely deawned to be run through the seed blower.

Squirreltail germinated very well at all temperatures, regardless of seed age, with or without stratification and regardless of storage treatment. Colder temperatures such as 4°C slowed the rate of germination but did not reduce total germination. The only condition which reduced germination significantly was long cold (4°C) dry storage followed by warm temperatures, which yielded 4 percent germination.

Planting of squirreltail could be done at almost any time after collection takes place as long as soil moisture is adequate. Cold dry storage is not recommended.

Sitanion hystrix

PHENOLOGY

1. Ripe Seed Period
2. Optimum Collection Period — (Late July - Early Aug 75-76)
3. Peak Ripe Seed
4. 50% Seed Shatter

COLLECTION

5. Methods — Hand-picked

CLEANING

6. Procedure — Mechanical flail with screen--
   30 sec. deawn
   Clipper 9/(1/25)
   Seed blower

7. Seed — Floret

SEED FILL-PRODUCTION		1975	1976
8. Seed Fill - %		84	97
9. Seed Fill - Range		72-98	94-100
10. Filled Seed Per Plant			
11. Filled Seed Per Inflorescence			
SEED WEIGHT			
12. Grams Per Liter		246	332
13. Seed Per Gram		440	348
14. Seed Per Pound	100% PLS SB	200,000	158,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
4^{o} dry	8 mo	--	10^{o}	14	90	6
4^{o} dry	8 mo	--	20^{o}	14	81	6
4^{o} dry	8 mo	--	30^{c}	14	4	20
20^{o} dry	12 mo	--	4^{o}	d	93	20
20 dry	12 mo	--	30^{o}	d	94	3

SPARTINA PECTINATA

Spartina pectinata Link (prairie cordgrass) is a tall (ours mostly 1 to 1.5 m), tough, strongly rhizomatous grass found in areas where the water table is near the surface.

Neither collection nor cleaning was a difficult process with prairie cordgrass.

Stratification of 1 to 2 months was necessary for high germination. Germination temperatures were favorable at 20°C constant, and both 20-5°C and 30-20°C alternating. Both 10°C and 30°C constant temperatures greatly reduced germination in stratified and unstratified seed alike.

Prairie cordgrass apparently should be planted in the fall of the year in which it is collected to obtain highest germination.

Spartina pectinata

PHENOLOGY

1. Ripe Seed Period
2. Optimum Collection Period — (Late July - Early Nov 75-76)
3. Peak Ripe Seed
4. 50% Seed Shatter

COLLECTION

5. Methods — Head cutter

CLEANING

6. Procedure — Head thresher--spiked cylinder and concave
   Mechanical flail--30 sec.
   Clipper 12/(1/25)

7. Seed — Spikelet

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %	93	97
9. Seed Fill - Range	89-95	93-100
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		
SEED WEIGHT		
12. Grams Per Liter	113	187
13. Seed Per Gram	282	291
14. Seed Per Pound 100% PLS SB	128,000	132,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	10 mo	1mo/4°wet	30-20°	14	91	3
20° dry	8 mo	1mo/4°wet	20-05°	14	87	6
20° dry	12 mo	2mo/4° dry	30-20°	8	80 pls	11
20° dry	12 mo	--	30-20°	8	49 pls	8
20° dry	4 mo	1mo/4°wet	20°	14	70	5

ARTEMISIA LUDOVICIANA

Artemisia ludoviciana Nutt. (cudweed sagewort) is a strongly rhizomatous perennial herb of the Composite family. It forms rather dense stands on disturbed sites and locally in the grasslands.

Flowering in the study area was evident in August and September. A high percentage of ripe seed were available by early November although some green seed were still present and some seed had been lost to shatter. However, the overlap of phenological stages does not pose a significant problem in seed collection.

No real problems were encountered in seed cleaning. Filled seed percentages were constantly above 90 after processing with the seed blower.

Germination was stimulated very markedly by a stratification period of 3 months duration and was significantly higher at 20°C and 20-5°C alternating germination temperatures than at higher or lower temperatures regardless of pregermination seed treatment.

Seeds not stratified improved in germination with age when germinated at 20-5°C alternating temperatures, to a lesser extent at 20°C constant temperatures, and not at all at 10 or 30°C temperatures.

There are indications of an afterripening requirement which stratification speeds up. Fall planting would appear to favor establishment of cudweed sagewort.

Artemisia ludoviciana

PHENOLOGY

1. Ripe Seed Period — October 22 -
2. Optimum Collection Period — November 1 -
3. Peak Ripe Seed — November
4. 50% Seed Shatter

COLLECTION

5. Methods — Head cutter

CLEANING

6. Procedure — Mechanical flail--30 sec.
Clipper (1/13)/blank
Seed blower

7. Seed

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %	97	96
9. Seed Fill - Range	95-99	95-99
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		
SEED WEIGHT		
12. Grams Per Liter		922
13. Seed Per Gram		5496
14. Seed Per Pound		2,495,000

SB

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	2 mo	3 mo/4°wet	20°	14	87	2
20° dry	5 mo	3 mo/4°wet	20-5°	14	84	3
20° dry	2 mo	--	20°	8	21	9

ASTRAGALUS BISULCATUS

Astragalus bisulcatus (Hook) Gray (two-grooved poisonvetch) is a large (ours 3-6 dm tall), clumped perennial herb of the Pea family. Our collections were made from plants growing on clayey upland soils. In 1976 flowering was completed by June 23, all seed were mature by July 26, and all seed had shattered from the plant by September 21.

Sand scarification followed by 20°C constant temperature and 8 hours of light proved the best for stimulation of germination. One trial without scarification or stratification showed slightly higher total germination and rate of germination in 20°C dark conditions than when 8 hours of light were added. Warm germination temperatures, either 30°C or 30°C-20°C alternating, reduced germination from that of 20°C. There was also a reduction in germination rate at 10°C.

Stratification of seed improves total germination over non-stratified seed; however, as stratification time is increased, total germination at 10°C germination temperature is improved and exceeds that obtained from warmer germination temperatures. In general, total germination is between 50 and 60 percent at 10°C when preceded by at least 2 months of stratification.

Germination without sand scarification or stratification was consistently low, as was germination from older (12 months) seed.

Both the natural seed dispersal time, August through September, and the germination response to stratification would suggest fall planting as favoring establishment of two-grooved poisonvetch.

Astragalus bisulcatus

PHENOLOGY

1. Ripe Seed Period	July 1 - September 8
2. Optimum Collection Period	July 12 - August 10
3. Peak Ripe Seed	July 26
4. 50% Seed Shatter	August 10

COLLECTION

5. Methods	Hand-stripped pods

CLEANING

6. Procedure	Head thresher--spiked cylinder and concave Mechanical flail--30 sec. Clipper 8/(1/25) Seed blower
7. Seed	

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %		80
9. Seed Fill - Range		68-96
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		

SEED WEIGHT

12. Grams Per Liter	973
13. Seed Per Gram	262
14. Seed Per Pound	119,000

SB

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	4 mo	sand	20°	8	70 pls	5
20° dry	4 mo	--	20°	8	52 pls	4
20° dry	6 mo	3 mo/4°wet	10°	14	55	10
20° dry	8 mo	2 mo/4°wet	20-5°	14	50	1
20° dry	12 mo	--	20-5°	14	18	2

ASTRAGALUS CRASSICARPUS

Astragalus crassicarpus Nutt. (groundplum milkvetch) is a low spreading perennial forb in the Pea family. It is found growing throughout the grasslands of the area.

Flowering was completed by late June, 1976, with green seed prevalent for almost a month. Ripening takes place rapidly over a 2-week period reaching 100 percent ripe seed by August 1 and for this area, seed had all shattered out by August 16.

Seed collection is a problem for this species since there is a short collection period, plants are infrequent, and pods are lying on the ground and rather firmly attached during the early ripe seed period.

Cleaning is also a problem as the pods are very tough and resistant to breakage unless they are thoroughly dried first. However, final cleaning by a seed blower yields a high percentage of filled seed.

Scarification with dry sand followed by germination at 20°C and 8 hours of light yielded 90 to 100 percent germination regardless of seed age.

Stratification improved germination over unstratified seed; however, maximum germination obtained from stratified seed was only 16 percent. Without the scarification treatment, germination was very slow and sporadic.

Poor establishment of groundplum milkvetch is to be expected without some seed scarification process.

Astragalus crassicarpus

PHENOLOGY

1. Ripe Seed Period	July 14 - August 14
2. Optimum Collection Period	July 22 - August 8
3. Peak Ripe Seed	July 30
4. 50% Seed Shatter	August 8

COLLECTION

5. Methods	Hand-picked

CLEANING

6. Procedure	Mechanical flail w/ screens--30 sec. Clipper 8/(1/18) Seed blower
7. Seed	

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %	99	95
9. Seed Fill - Range		92-97
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		

SEED WEIGHT			
12. Grams Per Liter			1170
13. Seed Per Gram		160	161
14. Seed Per Pound	SB	73,000	73,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	5 mo	sand scarif.	20°	8	100 pls	4
20° dry	12 mo	sand scarif.	20°	8	90 pls	9
20° dry	4 mo	1 mo/4°wet	20°	14	4	4
20° dry	5 mo	3 mo/4°wet	20°	14	16	1
20° dry	12 mo	--	20-05°	14	12	8

ASTRAGALUS STRIATUS

Astragalus striatus Nutt. (prairie milkvetch) is a perennial spreading forb of the Pea family, widespread and abundant in the plains up to open grassland associated with Ponderosa pine.

Flowering had ceased by the first week in July, 1976, and all seed were mature by the end of July. For approximately a 2-week period, collections can be made of ripe seed before shatter becomes significant. Collection is difficult due to plant growth form and small pod size.

Germination was favored by seed age, especially when subjected to long cold dry storage and by subsequent warm (30°C) germination temperatures. With scarification, germination from seed of short and long storage was much higher and age response was about the same. A noticeable difference in temperature response was found between low elevation (area 19) and high elevation (area 14) seed sources. The Colstrip source germinated much better if stored at warm (20°C) laboratory temperatures, as opposed to the above stated results.

Stratification of seed did not improve germination of this species over non-stratified seed and may reduce total germination in some cases.

Without scarification, planting should be done in warm moist soil in late spring of the following year. Unless germination deteriorates, as yet unknown, it may be even better to store the seed for 2 years under cool, dry conditions before planting.

Astragalus striatus

PHENOLOGY

1. Ripe Seed Period	July 20 - Sept 20
2. Optimum Collection Period	July 25 - August 13
3. Peak Ripe Seed	July 30
4. 50% Seed Shatter	August 13

COLLECTION

5. Methods	Hand-picked

CLEANING

6. Procedure	Mechanical flail w/ screens--30 sec. Clipper (1/13)/(1/25) Seed blower
7. Seed	

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %	98	92
9. Seed Fill - Range	97-99	91-92
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		
SEED WEIGHT		
12. Grams Per Liter	1081	992
13. Seed Per Gram	633	716
14. Seed Per Pound		
SB	287,000	325,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	12 mo	sand scarif	30°	8	82 pls	4
20° dry	5 mo	sand scarif	30°	8	69 pls	4
4° dry	12 mo	--	30°	8	34 pls	6
20° dry	12 mo	--	30°	8	19 pls	4
20° dry	12 mo	3 mo/4°wet	30-20°	14	18	4

CALOCHORTUS NUTTALLII

Calochortus nuttallii Baker (sego lily) is a showy white-flowered, erect (ours 2-4 dm tall), perennial bulbous herb of the Lily family. Flowers are present in May and June.

Seed collections were best made in early August to avoid green seed; however, some shatter was evident at that time.

Collection is a problem since during the seed ripe stage the capsule is open at the apex and seed are detached. Any disturbance, such as from wind, tends to throw the seed out. Also, the scattered single-stemmed growth habit is not conducive to collection of seed from wild plants.

For high germination, a long stratification period was required, followed by warm germination temperatures of 30-20°C alternating or 30°C constant. One, two, and three-months stratification followed by 30°C germination temperatures yielded 5, 18, and 50 percent germinations respectively for five-month old seed.

Germination without a pre-stratification treatment resulted in a maximum germination of 5 percent, the majority of trials being at 0 percent.

Fall planting in wet cold conditions appears to be required by the sego lily if it is to germinate well. Actual germination would be expected much later in the spring than other species, therefore necessitating special environmental conditions for establishment.

Calochortus nuttallii

PHENOLOGY

1. Ripe Seed Period
2. Optimum Collection Period — (Late July - Mid-Aug 1975)
3. Peak Ripe Seed
4. 50% Seed Shatter

COLLECTION

5. Methods — Hand-picked

CLEANING

6. Procedure — Clipper 12/(1/13)
Air-blasted 1 mm sieve 60 sec.

7. Seed

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %	91	
9. Seed Fill - Range	90-91	
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		
SEED WEIGHT		
12. Grams Per Liter	186	
13. Seed Per Gram	419	
14. Seed Per Pound		
SB	190,000	

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	12 mo	3 mo/4°wet	30-20°	14	80	1
20° dry	12 mo	2 mo/4°wet	30-20°	14	35	1
20° dry	12 mo	1 mo/4°wet	30-20°	14	5	1
20° dry	4 mo	3 mo/4°wet	30°	14	50	1
20° dry	4 mo	1 mo/4°wet	30°	14	5	2

CLEOME SERRULATA

Cleome serrulata Pursh. (rocky mountain bee plant) is an erect (ours 3-9 dm tall) annual of the Caper family, found mostly along roadsides and dry grasslands. It seems to occur only locally and comes and goes from year to year.

Seed collection and handling was very difficult because of the high moisture content of the foliage, the differential ripening time between each inflorescence, and the high percentage of green seed at the peak ripe seed stage. During the highest percentage of ripe seed, the total plant inflorescence will average 20 percent shattered seed, 30 percent green seed, and 10 percent buds and flowers, leaving about 40 percent of the capsules with ripe seed.

Cold, wet stratification was required for germination, and no germination was obtained without such treatment. Germination increased with length of stratification, seed age, and at the higher germination temperatures. As stratification increased, germination incrased significantly at 10°C germination temperature, being 1, 10, and 38 percent after 1, 2, and 3 months stratification respectively.

Some germination of rocky mountian bee plant would be expected from fall sowing of new seed; however, much higher germination would be expected by fall planting of one-year old seed in moist soil. Some plants would establish early during the cool period in the spring and others in late spring when temperatures had warmed up to daytime highs of 30°C providing sufficient moisture was present.

Cleome serrulata

PHENOLOGY

1. Ripe Seed Period
2. Optimum Collection Period — (Late Sept - Early Oct 75-76)
3. Peak Ripe Seed
4. 50% Seed Shatter

COLLECTION

5. Methods — Head cutter

CLEANING

6. Procedure — Head thresher w/ spiked cylinder and concave
Clipper 9/(1/18)

7. Seed

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %	100	91
9. Seed Fill - Range	99-100	71-100
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		
SEED WEIGHT		
12. Grams Per Liter	846	798
13. Seed Per Gram	135	147
14. Seed Per Pound SB	61,000	67,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	10 mo	3 mo/4°wet	30-20°	14	88	1
20° dry	10 mo	2 mo/4°wet	30-20°	14	75	1
20° dry	3 mo	3 mo/4°wet	30°	14	53	1
20° dry	8 mo	1 mo/4°wet	20-05°	14	30	4
20° dry	4 mo	1 mo/4°wet	10°	14	1	--

DALEA ENNEANDRA

Dalea enneandra Nutt. (bigtop dalea) is a tall (ours 6-10 dm), perennial herb of the Pea family found on a few restricted sites in the grasslands. Flowering begins in late June and is completed by early August. The green seed period overlaps nearly all the ripe seed period and seed shatter begins about the time that one-third of the seed are ripe. Wind storms remove a very high percentage of seed as they ripen. Highest percent ripe seed found was 34 percent of the total produced.

Seed production by each plant was quite low and collection was a problem due to the maturation phenology and scattered position of seed within the green canopy.

Although germination of new seed was low, after a short storage period of four months, germination was rather consistently above 60 percent with or without stratification. Newer seed were favored by 30°C germination temperatures while older seed (12 months) germinated equally at 20 or 30°C. As much as 68 percent germination was found during cold wet stratification of three months. The germination response to cold temperatures improved with seed age.

Either immediate fall planting or spring planting in moist soil appears to be suitable for establishing bigtop dalea.

Dalea enneandra

PHENOLOGY

1. Ripe Seed Period — August 1 - October 8
2. Optimum Collection Period — (August 13 - August 23)
3. Peak Ripe Seed — August 13
4. 50% Seed Shatter — (August 19)

COLLECTION

5. Methods — Hand picked

CLEANING

6. Procedure — Pods airblasted 1 mm screen
Screened (1/13)/blank

7. Seed

SEED FILL-PRODUCTION		1975	1976
8. Seed Fill - %		83	100
9. Seed Fill - Range		75-88	
10. Filled Seed Per Plant			
11. Filled Seed Per Inflorescence			
SEED WEIGHT			
12. Grams Per Liter		1040	1105
13. Seed Per Gram		305	351
14. Seed Per Pound	SB	138,000	159,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	4 mo	1 mo/4°wet	20°	14	85	2
20° dry	5 mo	--	20°	8	76 pls	1
20° dry	12 mo	--	20°	8	70 pls	1

ECHINACEA ANGUSTIFOLIA

Echinacea angustifolia D.C. (purple coneflower) is an upright (ours 2-4 dm tall), showy perennial herb of the Composite family. It is found scattered throughout the dry plains. Flowering began in late June and was completed by early August, 1976. All seed were mature by the first week in September.

Collection of seed was best in late October, November, or early December. Although seed shatter began in late October, prior to that time all seed were firmly attached to the recepticle and removal from the head was very difficult. Our collections made in early November were easily threshed and cleaned.

New seed (2-3 months of age) germinated best at warm temperatures (30°C), while cold (10°C) temperatures strongly reduced germination. Following longer storage or stratification, 20°C germination temperatures were best.

Seed stored for 12 months had fallen to about 50% of peak germination.

Unlike many other species, purple coneflower did not germinate (maximum 5 percent) during stratification; however, the rate of germination was increased by stratification.

Immediate fall planting would be the most desirable means of obtaining high germination followed by early spring planting the next year. High germination should not be in the latter case. Year-old seed planted in the fall would still be expected to yield some germination; however, maximum in our trials was 50 percent for year-old seed with or without stratification.

Echinacea angustifolia

PHENOLOGY

1. Ripe Seed Period — August 30 - (Nov/Dec)
2. Optimum Collection Period — Sept 1 - (Nov/Dec)
3. Peak Ripe Seed — Sept 8
4. 50% Seed Shatter

COLLECTION

5. Methods — Head cutter

CLEANING

6. Procedure — Head thresher w/ spiked cylinder and concave
Clipper 9/(1/13)
Seed blower

7. Seed

SEED FILL-PRODUCTION		1975	1976
8. Seed Fill - %		97	100
9. Seed Fill - Range		93-100	99-100
10. Filled Seed Per Plant		151	
11. Filled Seed Per Inflorescence		102	
SEED WEIGHT			
12. Grams Per Liter		316	274
13. Seed Per Gram		307	294
14. Seed Per Pound	100% PLS	197,000	
	SB	139,378	134,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	5 mo	3 mo/4°wet	20°	14	89	3
20° dry	5 mo	1 mo/4°wet	20°	14	68	4
20° dry	3 mo	--	20°	14	59	13
20° dry	10 mo	--	30°	d	44	8
20° dry	10 mo	--	10°	14	8	18

ERIOGONUM ANNUUM

Eriogonum annuum Nutt. (annual eriogonum) is an erect, tall (ours 6-9 dm), annual herb of the Buckwheat family. It was found locally abundant in the dry hills and plains, ours on sandy textured soils.

Flowering was completed in early October of 1975 and 1976 with seed collection being made from mid-October through mid- November.

Although collection was fairly simple due to the elevation of the inflorescence well above other vegetation, in cleaning, the achene was difficult to remove from the residual perianth. Air blasting and hand crushing were used on our small samples and both were effective but time-consuming. A hammer mill would be suitable for cleaning; however, seed damage should be rather high.

Germination was generally high under all treatments except high germination temperatures ($30^{o}C$) applied to seed which had not been stratified. Germination began immediately at all other temperatures down to and including $4^{o}C$. Older seed germinated only slightly better at colder temperatures.

Stratification was not needed and generally the longer stratification periods, 2 and 3 months, depressed total germination.

Germination rate increased with age. The fastest rate observed was 68 percent in the first 24 hours under $20^{o}C$ dark germination. Rate was depressed significantly by $30^{o}C$ and $40^{o}C$ germination temperatures.

No problems should be encountered in field germination whether annual eriogonum is planted the first fall, the following spring, or the second fall, except under conditions of warm soil temperatures. Spring planting appears to be best due to some reduction in germination caused by stratification.

Eriogonum annuum

PHENOLOGY

1. Ripe Seed Period
2. Optimum Collection Period — (Mid Oct - Early Nov 75-76)
3. Peak Ripe Seed
4. 50% Seed Shatter

COLLECTION

5. Methods — Head cutter

CLEANING

6. Procedure — Head thresher w/ spiked cylinder and concave
Clipper 9/(1/13)
Seed blower

7. Seed

SEED FILL-PRODUCTION		1975	1976
8. Seed Fill - %		100	100
9. Seed Fill - Range			99-100
10. Filled Seed Per Plant			
11. Filled Seed Per Inflorescence			
SEED WEIGHT			
12. Grams Per Liter		864	875
13. Seed Per Gram		3840	2769
14. Seed Per Pound	SB	1,743,000	1,257,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ. %	Days to 50% Germ.
20^{o} dry	3 mo	--	20^{o}	14	96	6
20^{o} dry	10 mo	--	4^{o}	d	63	6
20^{o} dry	10 mo	--	10^{o}	d	78	4
20^{o} dry	10 mo	--	20^{o}	d	87	1
20^{o} dry	10 mo	--	30^{o}	d	32	4

HEDEOMA DRUMMONDII

Hedeoma drummondii Benth. (drummond false pennyroyal) is an annual, spreading (ours 1-2 dm tall) herb of the Mint family. Our collections were made from sandy textured soils.

Flowering was completed in July and seed collection was made in early August. Seed collection was hindered by the low growth form and distribution of flowers well down each stem. Additionally, considerable threshing and mechanical abrasion were required to clean the seed.

Germination was very high under all treatments for new seed, 80 percent or more, except when warm temperatures (30°C) followed a short stratification period.

Optimal germination temperatures were from 10 to 20°C for all age classes of seed up to 12 months. Stratification of seed under 6 months old neither improved nor reduced germination except when followed by warm temperatures, which caused a reduction. For seed over 6 months old, stratification depressed germination and this was a progressive reduction with stratification time. For example, 12-month old seed stratified 3 months and germinated at 30-20°C alternating temperature only reached 15 percent germination.

Older seed not stratified have a very high germinability.

Immediate fall planting or early spring planting appear to be favorable times for the establishment of drummond false pennyroyal.

Hedeoma drummondii

PHENOLOGY

1. Ripe Seed Period
2. Optimum Collection Period — (Early August 75-76)
3. Peak Ripe Seed
4. 50% Seed Shatter

COLLECTION

5. Methods — Clipped plants

CLEANING

6. Procedure — Head thresher w/ spiked cylinder and concave
   Repeat
   Mechanical flail w/ screen--30 sec.
   Clipper (1/25)/blank
   Repeat flail and clipper
7. Seed — Seed blower

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %	98	98
9. Seed Fill - Range	97-100	97-100
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		
SEED WEIGHT		
12. Grams Per Liter	806	
13. Seed Per Gram	6110	6315
14. Seed Per Pound		
SB	2,774,000	2,867,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20^0 dry	4 mo	--	20^0	14	93	8
20^0 dry	12 mo	--	10^0	d	80	15
20^0 dry	12 mo	--	20^0	d	80	4
20^0 dry	12 mo	--	30^0	d	40	6
20^0 dry	12 mo	--	10^0	14	100	11

HEDYSARUM BOREALE

Hedysarum boreale Nutt. (northern sweetvetch) is a perennial, upright, (ours 3-5 dm tall), bushy herb of the Pea family. This plant was found locally abundant on sandy textured slopes and ridges in the grassland and lower hills. Flowering had ceased by the end of July in 1975 and 1976 and the pod or loments began falling from the plant in early August.

Seed collection was a problem due to the short retention time on the plant of the mature loment. Vacuum collection of loments from the ground worked very well and was much faster than hand stripping the seedheads. The inflorescence is well exerted and was easily removed by a head cutter.

Removal of the seed from the loment was difficult as the walls are tightly constricted about the seed. Mechanical abrasion by a mill did remove the seed; however, rather high seed damage resulted.

Best germination was obtained from newer seed germinated at 20°C day-night temperature. Both 30°C, 10°C, and dark depressed germination. Older seed (12 months) germinated best at 10°C day-night temperatures when not preceded by stratification and best at 20°C or above when preceded by stratification.

Germination during the stratification periods increased steadily with seed aged up to 6 months.

These germination trials would indicate that early spring planting of northern sweetvetch in cold moist soil would favor the highest germination.

Hedysarum boreale

PHENOLOGY

1. Ripe Seed Period
2. Optimum Collection Period — (Late July 75-76)
3. Peak Ripe Seed
4. 50% Seed Shatter

COLLECTION

5. Methods — Hand-stripped

CLEANING

6. Procedure — Air-blasted 1 mm sieve
Screened (1/18)/blank

7. Seed

SEED FILL-PRODUCTION		1975	1976
8. Seed Fill - %		97	87
9. Seed Fill - Range		94-99	85-89
10. Filled Seed Per Plant			
11. Filled Seed Per Inflorescence			
SEED WEIGHT			
12. Grams Per Liter		1054	1026
13. Seed Per Gram		190	213
14. Seed Per Pound	SB	86,000	96,700

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	4 mo	--	20°	14	82	5
20° dry	2 mo	--	10°	d	18	25
20° dry	12 mo	--	10°	d	56 pls	11
20° dry	2 mo	--	20°	d	34	9
20° dry	4 mo	--	20°	14	82	5

HELIANTHUS RIGIDUS

Helianthus rigidus (Cass.) Desf. (stiff sunflower) is an erect (ours 2 dm tall) single-stemmed rhyzomatous herb of the Composite family. In our area, plants were found locally abundant on sandier soils.

Flowering was complete by the end of July in 1976, seed began to ripen in late August, and seed shatter began in late September, giving a seed collection period of at least 3 weeks. Complete seed shatter was reached by the end of the first week in October.

The well-elevated heads were easily removed by hand stripping or clipping and when well dried, were easily threshed and cleaned.

Maximum germination was obtained from 8-10 month old seed stratified for 1 to 2 months and germinated at 20-5°C alternating temperatures. Longer stratification reduced germination at the above temperatures. Without stratification, germination was 12 percent or less. With stratification followed by constant temperatures and the 30-20°C alternating temperatures, maximum germination was 9 percent. Warm temperatures had a significant inhibitory effect on germination.

Data indicate very early spring planting is best to obtain highest germination of stiff sunflower. The seed require a short stratification period only, too long a period will likely reduce total germination.

Helianthus rigidus

PHENOLOGY

1. Ripe Seed Period	August 23 - September 30
2. Optimum Collection Period	August 28 - September 26
3. Peak Ripe Seed	September 8
4. 50% Seed Shatter	September 26

COLLECTION

5. Methods	Head cutter

CLEANING

6. Procedure	Head thresher w/ spiked concave and cylinder Mechanical flail--30 sec Clipper 9/(1/18) Seed blower
7. Seed	

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %	98	91
9. Seed Fill - Range	95-100	60-100
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		

SEED WEIGHT

12. Grams Per Liter	822		796
13. Seed Per Gram	224		217
14. Seed Per Pound SB	102,000		98,500

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	10 mo	1 mo/4°wet	20-05°	14	85	9
20° dry	10 mo	1 mo/4°wet	30-20°	14	3	6
20° dry	4 mo	3 mo/4°wet	20°	14	9	5
20° dry	10 mo	--	20-05°	14	6	25
4° dry	8 mo	--	10°	14	12	19

LINUM PERENNE

Linum perenne Pursh. (blue flax) is an erect (ours 3-4 dm tall), few-to-several stemmed perennial herb of the Flax family. It was found scattered throughout much of the area in the grasslands.

Flowering had ceased by the end of June in 1976 with a majority of the seed ripe in 2 to 3 weeks. The collection period was short beginning at the time peak seed ripe was reached and ending within 2 weeks when most of the seed had wind shattered out.

Collection was not a significant problem, as the seed head is in the upper canopy. Cleaning the seed, however, required repeated threshing and milling to remove and reduce chaff size for final separation.

Optimum germination temperature was 20°C even though total germination might not have been significantly different from 10°C or even 4°C over an extended period. The rate of germination was much faster, however. Older seed germinated at a faster rate at cold temperatures, 10°C or 4°C, than newly collected seed.

Although stratification was not needed to obtain good germination, when it was applied to newly collected seed for 3 months, the final germination percentages obtained from 10, 20, and 30°C germination temperatures were not significantly different from the maximum germination obtained on older seed which were unstratified. Cold wet stratification needs to be for a 2-month period or longer to obtain maximum germination. In general, cold temperatures slowed the germination rate and warm temperatures, 30°C constant, depressed total germination.

Blue flax should germinate well with either fall or spring planting. Planting the second fall would tend to increase the number of seedlings emerging during the fall period over that from planting the first fall.

Linum perenne

PHENOLOGY

1. Ripe Seed Period	July 2 - August 13
2. Optimum Collection Period	July 7 - July 18
3. Peak Ripe Seed	July 13
4. 50% Seed Shatter	July 18

COLLECTION

5. Methods	Hand-stripped

CLEANING

6. Procedure	Head thresher w/ spiked cylinder and concave Mechanical flail w/ screen--30 sec. Clipper 7/(1/18) Seed blower
7. Seed	

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %	92	94
9. Seed Fill - Range	85-99	90-98
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		
SEED WEIGHT		
12. Grams Per Liter	627	690
13. Seed Per Gram	685	596
14. Seed Per Pound		
SB	311,000	271,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	12 mo	--	10°	14	85	11
20° dry	12 mo	--	20°	d	84	5
20° dry	3 mo	--	20°	d	56	12
20° dry	4 mo	--	4°	d	0	--
20° dry	12 mo	--	4°	d	39	28

LINUM RIGIDUM

Linum rigidum Pursh. (stiffstem flax) is an erect (ours 1-2 dm tall), usually annual herb of the Flax family. It was well scattered throughout the grasslands and only locally abundant.

Collections were made in August and September from a well-exerted inflorescence. Cleaning was a rather lengthy process to remove the capsule walls and inner partitions. Capsules needed to be well dried before the cleaning process.

Germination took place soon after seed maturation without any stratification being applied. When stratification was applied, best germination resulted when it did not exceed 1 month and when it was followed by 20°C or 30°C germinating temperatures. Stratification for longer periods and germination at 10°C reduced total germination.

Following extended cold treatment, either wet or dry, a warm 30°C germination temperature strongly depressed total germination, in one case to 1 percent. Seeds were best stored at 20°C, in which case germination at all temperatures exceeded 70 percent.

Spring planting after 20°C dry storage would yield highest germination in stiffstem flax, although immediate fall planting would yield fall as well as some spring germination. No reduction in germination was apparent in year-old seed.

Linum rigidum

PHENOLOGY

1. Ripe Seed Period
2. Optimum Collection Period — (Aug - Sept 75-76)
3. Peak Ripe Seed
4. 50% Seed Shatter

COLLECTION

5. Methods — Head cutter

CLEANING

6. Procedure — Head thresher w/ spiked concave and cylinder
   Mechanical flail w/ screen--30 sec.
   Clipper 7/blank
   Seed blower
7. Seed

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %	96	98
9. Seed Fill - Range	90-100	95-100
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		
SEED WEIGHT		
12. Grams Per Liter	878	774
13. Seed Per Gram	1058	1248
14. Seed Per Pound		
SB	480,000	583,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	2 mo	--	20°	14	89	12
20° dry	5 mo	1 mo/4°wet	20°	14	88	4
4° dry	8 mo	--	20°	14	52	15
10° dry	12 mo	--	20-05°	14	74	6

MENTZELIA DECAPETALA

Mentzelia decapetala (Pursh) Urban & Gilg (tenpetal blazingstar) is a tall (ours 50-70 dm) stout, much-branched, showy herb of the Loasa family. Plants are locally abundant on rock faces and coarse gravelly soils.

Seed collection was complicated by unequal maturation of capsules. At the optimum collection period only about 60 percent of the seed were ripe, 10 percent had shattered and 30 percent were still green. Wind shatter takes place soon after the seed ripe stage has been reached by the capsule. Flowers and ripe capsules were present on the same plant.

Optimum germination temperature was 20°C. Higher and lower temperatures tend to depress germination amount and rate. Stratification was desirable, and when followed by 20°C germination temperature, no difference was found between 1, 2, or 3 months stratification time.

Germination declined in seed over 8 months in storage, although stratification improved germination on the older seed lots.

Planting seed of tenpetal blazingstar should be done the fall of the first year. Spring planting would appear to markedly reduce germination both due to seed age and absence of cold wet stratification.

Mentzelia decapetala

PHENOLOGY

1. Ripe Seed Period
2. Optimum Collection Period — (Oct - Early Nov 75-76)
3. Peak Ripe Seed
4. 50% Seed Shatter

COLLECTION

5. Methods — Head cutter

CLEANING

6. Procedure — Head thresher w/ spiked cylinder and concave
   Clipper 8/(1/25)
   Seed blower

7. Seed

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %	100	100
9. Seed Fill - Range		97-100
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		
SEED WEIGHT		
12. Grams Per Liter	514	475
13. Seed Per Gram	709	737
14. Seed Per Pound		
SB	322,000	335,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	3 mo	1 mo/4°wet	20°	14	72	2
20° dry	3 mo	3 mo/4°wet	30°	14	42	6
20° dry	3 mo	2 mo/4°wet	10°	14	48	6
20° dry	2 mo	--	20°	14	54	12
20° dry	8 mo	--	20°	14	18	6

MONARDA FISTULOSA

Monarda fistulosa L. (horse mint) is a sparingly branched, erect (ours about 10 dm tall) perennial herb of the Mint family. It was found in the swales and moister sites of the grasslands.

Collection and cleaning were relatively easy due to the well-elevated seed heads, rather uniform ripening, and a suitable seed retention period.

Germination was high for all treatments with the exception of immediate germination without stratification and unstratified older seed (8 months or more) germinated at the cooler 10 or 4°C temperatures. Maximum germination was obtained from a long stratification, 3 months, followed by 20-5°C alternating germination temperature.

Horse mint probably could be planted the first fall, late the first spring, or the second fall with about equal germination.

Monarda fistulosa

PHENOLOGY

1. Ripe Seed Period
2. Optimum Collection Period — (Early Sept 1975-76)
3. Peak Ripe Seed
4. 50% Seed Shatter

COLLECTION

5. Methods — Head cutter

CLEANING

6. Procedure — Head thresher w/ spiked concave and cylinder
Clipper (1/15)/blank
Seed blower

7. Seed

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %	76	64
9. Seed Fill - Range	57-89	5-96
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		
SEED WEIGHT		
12. Grams Per Liter	859	786
13. Seed Per Gram	2568	3038
14. Seed Per Pound SB	1,166,000	1,379,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	8 mo	3 mo/4°wet	20-5°	14	97	1
20° dry	8 mo	1 mo/4°wet	20-5°	14	87	4
20° dry	8 mo	--	20°	14	83	7
20° dry	1 mo	--	20°	--	4	8
20° dry	8 mo	--	20°	--	77	4

PETALOSTEMON CANDIDUM

Petalostemon candidum (Willd.) Michx. (white prairie-clover) is an ascending, branched from base, (ours about 2-4 dm tall), perennial herb of the Pea family. It was scattered throughout the uplands and exposed sites in the grasslands, and only locally abundant.

Collection posed a problem due to the high percentage of green seed and/or shattered seed relative to the percentage of ripe seed. Maximum ripe seed available at any one time ranged from a low of 19 percent to a high of 70 percent. In order to keep the green seed fraction below 10 percent, shatter loss ranged from 20 to 85 percent. Green seed were found to be very subject to fungi damage both during storage if not well dried and ventilated and during germination.

Removal of the pod walls from the seed was possible with a mechanical flail although some seed damage occurred. Removal of the pod was necessary since we found very heavy fungi-caused mortality to the germinating seedling regardless of the agent used to control the fungi without such removal.

Germination is optimal at warm temperatures: 30°C when preceded by warm 20°C dry storage of up to one year or long cold (4°C) dry storage. Germination percentage and rate tended to increase with seed age up to one year.

Stratification depressed germination in white prairie-clover although 3-month stratification had no greater effect than 1-month stratification.

Based on the above results, seeds should be stored over winter in a dry place and planted in late spring into warm soil. A fungicide also appears very necessary for high germination in this species.

Petalostemon candidum

PHENOLOGY

1. Ripe Seed Period	July 12 - August 30
2. Optimum Collection Period	August 2 - August 11
3. Peak Ripe Seed	August 4
4. 50% Seed Shatter	August 19

COLLECTION

5. Methods	Hand-stripped

CLEANING

6. Procedure	Mechanical flail--30 sec. Clipper 7/(1/25) Seed blower

7. Seed

SEED FILL-PRODUCTION		1975	1976
8. Seed Fill - %		88	93
9. Seed Fill - Range		81-95	87-100
10. Filled Seed Per Plant		85	
11. Filled Seed Per Inflorescence		5	
SEED WEIGHT			
12. Grams Per Liter		1027	996
13. Seed Per Gram		783	666
14. Seed Per Pound	100% PLS	441,000	
	SB	355,000	303,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	3 mo	--	30°	14	79	5
4° dry	10 mo	--	30°	14	76	1
20° dry	3 mo	--	20°	14	75	6
20° dry	3 mo	--	20°	d	22	6
20° dry	12 mo	--	20°	d	66 pls	2

PETALOSTEMON PURPUREUM

Petalostemon purpureum (Vent.) Rydb. (purple prairie-clover) is an ascending (ours 2-5 dm tall), branched at the base, herb of the Pea family. It was found throughout much of the uplands and slopes in the grasslands.

Flowering ceased by the end of July in 1975 and 1976. Although the best seed collection period was in late August, green seed were still present and seed loss from shatter was in progress. One accession averaged 60 percent green seed, 20 percent ripe seed, and 20 percent shatter while a second reached 100 percent ripe seed before shatter began.

Fungi damage on green seed and seed from which the pod had not been removed was a serious problem. Well-dried seed and considerable mechanical abrasion were needed before storage in well ventilated containers.

Germination was highest if the seed was stored at 4°C dry conditions over winter. Germination temperature following storage was best at 20 or 30°C with the former being slightly better. Long storage at 20°C dry followed by 20°C germination temperature yielded a 10 to 15 percent reduction in germination from the colder storage temperature.

Stratification of various lengths followed by germination under the many temperatures applied yielded germination between 50 and 75 percent. In general, stratification reduced total germination over the non-stratified treatment.

Purple prairie-clover could be planted in the fall; however, best germination should be obtained from cold dry storage and mid-spring planting into fairly warm soil.

Petalostemon purpureum

PHENOLOGY

1. Ripe Seed Period	August 7 - September 23
2. Optimum Collection Period	August 8 - September 16
3. Peak Ripe Seed	September 8
4. 50% Seed Shatter	September 16

COLLECTION

5. Methods	Hand-stripped pods

CLEANING

6. Procedure	Mechanical flail--30 sec. Clipper (1/13)/(1/25) Repeat flail and clipper Seed blower

7. Seed

SEED FILL-PRODUCTION		1975	1976
8. Seed Fill - %		97	90
9. Seed Fill - Range		89-100	84-97
10. Filled Seed Per Plant			
11. Filled Seed Per Inflorescence			
SEED WEIGHT			
12. Grams Per Liter		1175	1036
13. Seed Per Gram		570	612
14. Seed Per Pound	100% PLS	260,000	
	SB	259,000	278,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
4° dry	12 mo	--	20°	8	95 pls	2
4° dry	12 mo	--	20°	d	94 pls	2
20° dry	2 mo	--	20°	d	30	24
20° dry	12 mo	--	20°	d	86 pls	3
20° dry	5 mo	1 mo/4°wet	20°	14	67	2

POTENTILLA GLANDULOSA

Potentilla glandulosa Lindl. (gland cinquefoil) is an erect, (ours 3-4 dm tall), branching above, herb of the Rose family. It was locally abundant on exposed sites of hillsides and slopes in the grassland.

Seed was easily obtained in early August from well-elevated heads. Cleaning was a problem in that the surrounding chaff was difficult to remove. Mechanical abrasion was usable although seed damage did occur.

Stratification promoted germination on both new and old seeds. Only a 1-month stratification was needed since no improvement resulted from longer stratification.

Germination did improve with seed age in those trials not preceded by stratification.

Fall planting would favor high germination in gland cinquefoil.

Potentilla glandulosa

PHENOLOGY

1. Ripe Seed Period
2. Optimum Collection Period — (Early August 75-76)
3. Peak Ripe Seed
4. 50% Seed Shatter

COLLECTION

5. Methods — Head cutter

CLEANING

6. Procedure — Head thresher w/ spiked cylinder and concave
Screened (1/25)/blank
Seed blower

7. Seed

SEED FILL-PRODUCTION		1975	1976
8. Seed Fill - %		100	90
9. Seed Fill - Range		--	85-95
10. Filled Seed Per Plant			
11. Filled Seed Per Inflorescence			
SEED WEIGHT			
12. Grams Per Liter		881	855
13. Seed Per Gram		7441	9755
14. Seed Per Pound	SB	3,378,000	4,429,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	8 mo	1 mo/4°wet	20-05°	14	92	4
20° dry	6 mo	1 mo/4°wet	20°	14	89	4
20° dry	12 mo	1 mo/4°wet	30-20°	14	86	2
20° dry	12 mo	--	20-05°	14	49	16
20° dry	3 mo	--	20°		8	24

RATIBIDA COLUMNIFERA

Ratibida columnifera (Nutt.) Wooton and Standl (prairie coneflower) is an erect (ours 3-4 dm tall), branched from the base, perennial herb in the Composite family. It was found scattered throughout the grassland with areas of very high abundance.

The flower heads are well elevated and ceased to flower in late July of 1975 and 1976. Seed collection was made over a long period; however, late September collections generally contained no green seed and loss from shatter was minimal. Our collections in early November showed a range of seed shatter of 5 to 70 percent.

Optimal germination temperature was at 20°C applied to seed stored for 2 months or more, while 30°C was equally as good only on older (8-12 months) seed. Stratification appears to depress germination when applied to 8-12 month old seed. The colder 10°C germination temperature reduced germination significantly on both new and older seed. Storage temperature did not influence germination.

Since 4°C, 20°C storage and long cold wet stratification at 4°C all yield high total germination percentages, either fall or spring planting should be acceptable. However, dry storage and planting in mid-spring with soil temperatures up around 20°C appears to be the better procedure for prairie coneflower.

Ratibida columnifera

PHENOLOGY

1. Ripe Seed Period	July 30 - November 15
2. Optimum Collection Period	August 5 - October 2
3. Peak Ripe Seed	August 13
4. 50% Seed Shatter	October 2

COLLECTION

5. Methods	Hand-stripped

CLEANING

6. Procedure	Mechanical flail--30 sec. Clipper (1/13)/(1/25) Seed blower

7. Seed

SEED FILL-PRODUCTION		1975	1976
8. Seed Fill - %		80	89
9. Seed Fill - Range		12-99	70-100
10. Filled Seed Per Plant		678	
11. Filled Seed Per Inflorescence		166	
SEED WEIGHT			
12. Grams Per Liter		529	469
13. Seed Per Gram		1616	1485
14. Seed Per Pound	100% PLS	900,000	
	SB	733,000	674,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	12 mo	--	20°	d	99	2
20° dry	12 mo	--	20°	14	92	2
20° dry	12 mo	--	30°	14	95	2
20° dry	10 mo	--	10°	14	58	9
20° dry	2 mo	--	20°	14	81	7

RUMEX CRISPUS

Rumex crispus L. (curled dock) is an erect (ours 5-8 dm tall), taprooted perennial herb of the Buckwheat family. It possesses a deep tap root and was found on disturbed or otherwise open moist sites.

Collection was by hand-stripping; however, a head cutter would work also. Removal of wings by mechanical abrasion was necessary to obtain clean seed.

High germination without stratification must be preceded by a long cold dry storage period followed by cooler, 10 to 20°C germination temperatures. Germination was poor, less than 25 percent, on all unstratified seed regardless of age and on stratified seed less than 8 months old. Stratification did not improve germination until seed had gone through approximately an 8-month afterripening period. Following stratification, either warm or cold temperatures yield very high germination. For older seed, increasing the length of stratification only slightly increased germination.

Fall planting of year-old seed appears to be best for high incidence of establishments. Cold dry storage over winter and planting in early spring is a possibility.

Curled dock is certainly a questionable species to add in a seed mix. The information provided may best be used to assist in reducing its abundance.

Rumex crispus

PHENOLOGY

1. Ripe Seed Period
2. Optimum Collection Period — (Late July - Late Aug 75-76)
3. Peak Ripe Seed
4. 50% Seed Shatter

COLLECTION

5. Methods — Hand-stripped

CLEANING

6. Procedure — Mechanical flail--30 sec.
Screened (1/15)/blank
Seed blower

7. Seed

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %	99	92
9. Seed Fill - Range	98-100	89-96
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		
SEED WEIGHT		
12. Grams Per Liter	812	292
13. Seed Per Gram	821	572
14. Seed Per Pound		
SB	373,000	260,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	8 mo	3 mo/4°wet	20-5°	14	95	2
20° dry	8 mo	--	20-5°	14	23	3
4° dry	8 mo	--	10°	14	71	9
4° dry	8 mo	--	20°	14	75	4
4° dry	8 mo	--	30°	14	24	1

SPOROBOLUS CRYPTANDRUS

Sprobolus cryptandrus (Torr.) A. Gray (sand dropseed) is a small (ours 3-6 dm tall), tufted, perennial grass found on the sandier soils throughout the area.

Since the seedheads are not of uniform height, and since they open unevenly, collection was somewhat of a problem; however, cleaning was relatively easy.

Germination was essentially non-existent without stratification. Maximum germination was obtained by stratifying 12-month old seed for 2 months followed by 30-20°C alternating temperatures. One accession yielded 99 percent germination under such conditions. Storage at 20°C was better than under unheated or 4°C conditions. Longer, 3-month, stratification was required to obtain high germination at cooler temperatures. Stratification of seed under 6 months of age yielded a maximum of 52 percent germination.

Sand dropseed should ideally be planted a year after harvest in the fall. A much poorer second choice would be the immediate fall.

Sporobolus cryptandrus

PHENOLOGY

1. Ripe Seed Period
2. Optimum Collection Period — (Late July - Early Aug 75-76)
3. Peak Ripe Seed
4. 50% Seed Shatter

COLLECTION

5. Methods — Head cutter

CLEANING

6. Procedure — Head thresher--spiked cylinder and concave
   Clipper (1/18)/6x60

7. Seed — Caryopsis--floret

		1975	1976
SEED FILL-PRODUCTION			
8. Seed Fill - %		98	98
9. Seed Fill - Range		96-99	96-99
10. Filled Seed Per Plant			
11. Filled Seed Per Inflorescence			
SEED WEIGHT			
12. Grams Per Liter		735	616
13. Seed Per Gram		9198	9565
14. Seed Per Pound	SB	4,176,000	4,343,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	12 mo	2 mo/4°wet	30-20°	14	95	2
20° dry	12 mo	1 mo/4°wet	30-20°	14	8	2
20° dry	6 mo	2 mo/4°wet	10°	14	0	-
20° dry	6 mo	2 mo/4°wet	20°	14	17	5
20° dry	6 mo	2 mo/4°wet	30°	14	27	4

STIPA COMATA

Stipa comata Trin. & Rupr. (needle-and-threadgrass) is a medium height (ours 3-6 dm tall), somewhat divergent, perennial bunchgrass found over much of the grassland. It was found in very high abundance locally.

Collection of seed was a problem because of the long twisted awns. Dried seed sent through a mechanical flail or hammer mill did yield a high percentage of deawned seed with little seed damage.

Maximum germination was obtained from unstratified 12-month old seed germinated at 20°C. Values for germination in excess of 80 percent were obtained for 3 accessions using this treatment. Both lower and higher temperatures reduced germination drastically, with 30°C reducing germination by about 50 percent and 10°C reducing it by 90 percent or more.

Maximum germination with stratification was 20 percent.

Germination of new seed was low. Our high was 48 percent for 2-month old seed, and 54 percent for 5-month old seed at 20°C.

If a projection can be made based on the trials, needle-and threadgrass seed should be planted the second spring after collection after approximately 18-20 months storage at 20°C.

Stipa comata

PHENOLOGY

1. Ripe Seed Period
2. Optimum Collection Period — (Early July - Early Aug 75-76)
3. Peak Ripe Seed
4. 50% Seed Shatter

COLLECTION

5. Methods — Hand-stripped

CLEANING

6. Procedure — Mechanical flail--30 sec.
Clipper 9/(1/25)
Repeat flail and clipper
Seed blower

7. Seed — Floret

SEED FILL-PRODUCTION		1975	1976
8. Seed Fill - %		69	78
9. Seed Fill - Range		35-80	75-80
10. Filled Seed Per Plant		48	
11. Filled Seed Per Inflorescence		8	
SEED WEIGHT			
12. Grams Per Liter		436	466
13. Seed Per Gram		252	186
14. Seed Per Pound	100% PLS	169,000	
	SB	114,000	84,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	12 mo	--	20°	8	65 pls	6
unheated	12 mo	--	20°	8	59 pls	5
20° dry	12 mo	--	20-05°	14	14	18
20° dry	8 mo	3 mo/4°wet	20-05°	14	13	1
20° dry	12 mo	3 mo/4°wet	30-20°	14	20	1

STIPA VIRIDULA

Stipa viridula Trin. (green needlegrass) is a tall (ours 1.1-1.6 m), robust, perennial bunchgrass found on some of the deeper fertile soils and locally abundant.

Flowering was complete by mid-June, 1976, and 100 percent green seed were present by the end of the third week in June. At the maximum ripe seed stage, total ripe seed ranged from 40 to 70 percent of all seed produced. Seed loss to shatter was in progress almost as soon as the seed began ripening, so that 38 percent shatter, 54 percent ripe, and 8 percent green seed would be a typical situation. There appears to be little more than a week for optimum collection.

Seed are easily removed by a head cutter and after air drying, cleaning is relatively easy.

Optimum germination was obtained by storing the seed for 12 months followed by 20 or 30°C germination temperatures or by stratifying 12-month old seed for 1 month and germinating them at 10°C. A consistent light inhibition was found.

Long cold storage at 4°C dry almost eliminated germination as did alternating temperatures applied to unstratified seed.

Newer seed germination was found to be favored by stratification, however, total germination was well below optimum.

Green needlegrass should be stored at 20°C for 12 months or more, and based on an extrapolation of the tests, planted in the early spring of the second year for highest germination.

Stipa viridula

PHENOLOGY

1. Ripe Seed Period	June 23 - July 25
2. Optimum Collection Period	July 7 - July 17
3. Peak Ripe Seed	July 12
4. 50% Seed Shatter	July 17

COLLECTION

5. Methods	Hand-stripped

CLEANING

6. Procedure	Mechanical flail--30 sec. Clipper 7/(1/25) Seed blower
7. Seed	Floret

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %	96	89
9. Seed Fill - Range	93-100	78-100
10. Filled Seed Per Plant	189	
11. Filled Seed Per Inflorescence	28	

SEED WEIGHT

12. Grams Per Liter		790	803
13. Seed Per Gram		287	288
14. Seed Per Pound	100% PLS	185,000	
	SB	130,000	131,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	12 mo	--	20°	d	83 pls	5
20° dry	12 mo	--	10°	d	36 pls	14
20° dry	12 mo	1 mo/4°wet	10°	d	88	5
20° dry	12 mo	1 mo/4°wet	10°	8	68	9
20° dry	6 mo	1 mo/4°wet	10°	14	45	9

ARTEMISIA CANA

Artemisia cana Pursh (silver sagebrush) is a strongly branched, bushy, medium height (ours 4-8 dm tall), shrub of the Composite family, abundant through much of the grassland.

Flowering had ceased by the first week in October and mature seed appeared by the last week in October of 1976. All seed were mature by the second week in November.

Although collection was by hand-stripping of heads, a head cutter is usable for rapid removal where abundant flowers are produced. Cleaning was fairly easy; however, mechanical treatment such as flails or hammer mills should be limited since chaff is reduced to seed size and becomes difficult to remove by screening or seed blower.

Germination was very high regardless of the seed age, whether stratified or not, and germination temperature. Colder germination temperatures, 10°C and 4°C, did reduce the rate of germination. One accession of 2-month old seed reached only 26 percent germination in 4°C dark conditions, while older seed, 12 months, germinated much faster at this temperature, 73 percent.

These trials indicate that silver sagebrush could be planted anytime after collection, at least through the second fall. The only requirement would be adequate soil moisture for establishment.

Artemisia cana

PHENOLOGY

1. Ripe Seed Period — October 30 -
2. Optimum Collection Period — Nov 2 -
3. Peak Ripe Seed — Nov 11
4. 50% Seed Shatter

COLLECTION

5. Methods — Hand-stripped

CLEANING

6. Procedure — Mechanical flail--60 sec.
Clipper (1/13)/6x60
Seed blower

7. Seed

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %	96	92
9. Seed Fill - Range	91-99	84-97
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		
SEED WEIGHT		
12. Grams Per Liter	572	441
13. Seed Per Gram	1917	1810
14. Seed Per Pound		
SB	870,000	822,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	12 mo	--	10°	8	97 pls	6
20° dry	12 mo	--	30°	8	94 pls	2
20° dry	12 mo	--	4°	d	73 pls	19
20° dry	2 mo	1 mo/4°wet	20°	14	97	1
20° dry	2 mo	--	20°	8	85	3

ARTEMISIA TRIDENTATA WYOMINGENSIS

Artemisia tridentata wyomingensis Nutt. (Wyoming big sagebrush) is a branched, bushy, low-medium height (ours 3-7 dm tall), shrub of the Composite family, of high abundance throughout much of the grassland.

Flowering was completed by the end of September in 1976, and seed began to ripen by the end of the third week in October. Seed began to shatter out of the heads before all the seed had ripened, although during the second week of November, all seed had matured and shatter loss was less than 5 percent of the total produced.

Collection by hand-stripping and head cutting were used, depending on the density of inflorescences. Material needs to be well-dried before cleaning.

Optimum germination from new seed was obtained after 2 to 3 months stratification. No significant difference was observed between the various germination temperatures, as percentage germination ranged between 89 and 100. Unstratified new seed ranged from 4 to 72 percent germination, being lowest at 4°C and highest at 30°C.

Older seed germinated very well, 97 percent, at either 20 or 30°C constant and at 20-5°C or 30-20°C alternating temperatures without stratification. There was a steady increase in germination rate at 4 and 10°C as seed became older. Stratification of year-old seed did not reduce germination below that of unstratified seed.

Based on these trials, seed of Wyoming big sagebrush can be effectively planted anytime after collection through the second fall and perhaps even later.

Artemisia tridentata wyomingensis

PHENOLOGY

1. Ripe Seed Period — October 25 -
2. Optimum Collection Period — November 1 -
3. Peak Ripe Seed — November 11
4. 50% Seed Shatter

COLLECTION

5. Methods — Hand-clipped

CLEANING

6. Procedure — Oven dried 24 hrs at 25°C
Mechanical flail--30 sec.
Clipper (1/13)/6x60
Seed blower

7. Seed

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %	94	95
9. Seed Fill - Range	91-97	91-99
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		
SEED WEIGHT		
12. Grams Per Liter	630	498
13. Seed Per Gram	3430	1923
14. Seed Per Pound		
SB	1,557,000	873,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	12 mo	--	20°	d	94 pls	6
20° dry	12 mo	--	20°	8	94 pls	4
20° dry	2 mo	--	20°	8	86 pls	7
20° dry	12 mo	--	10°	8	89 pls	8
20° dry	12 mo	--	30°	8	97 pls	4

CERATOIDES LANATA

Ceratoides lanata (Pursh) J.T. Howell (winterfat) is a branched, sometimes woody, crowned, low (ours 2-5 dm tall) shrub of the Goosefoot family. It is found widely scattered and locally abundant on the upland grasslands.

Flowering was completed by the third week in July of 1976, and seed began to mature the first week in October. As much as 16 percent green seed was found at the maximum concentration period of mature seed. Seed loss from shatter began before all seed were mature and reached 80 percent by mid-November. Collection and cleaning were not a significant problem, however, seed production from winterfat was extremely poor both in 1975 and 1976.

Germination tests were not extensive on winterfat due to a limited seed supply. Very high germination was obtained by dry 20°C storage for at least 2 months, followed by germination at 20 or 30°C with light.

One-month old seed germinated to a much lesser extent than older seed.

Based on limited tests, winterfat seed should be stored over winter at 20°C and planted in late spring.

Ceratoides lanata

PHENOLOGY

1. Ripe Seed Period — September 30 - November 11
2. Optimum Collection Period — October 5 - October 28
3. Peak Ripe Seed — October 8
4. 50% Seed Shatter — October 28

COLLECTION

5. Methods — Head cutter

CLEANING

6. Procedure — Mechanical flail
Clipper 9 (1/13)

7. Seed

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %	100	100
9. Seed Fill - Range		99-100
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		
SEED WEIGHT		
12. Grams Per Liter	776	614
13. Seed Per Gram	463	278
14. Seed Per Pound		
SB	210,000	126,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20^{o} dry	3 mo	--	20^{o}	8	87 pls	2
20^{o} dry	2 mo	--	30^{o}	14	80	4
20^{o} dry	1 mo	--	20^{o}	d	14	12

CHRYSOTHAMNUS NAUSEOSUS

Chrysothamnus nauseosus (Pall.) Britt. (rubber rabbitbrush) is a medium-height (ours 5-8 dm tall), branched shrub of the Composite family, found well scattered throughout the grasslands.

In 1976 flowering was complete by late September and seed were all mature by the second week in October. Seed loss to shatter began before all seed were mature.

Seed collection was fairly rapid by knocking them from the plant into containers. The pappus was removed by a short treatment with the mechanical flail without damage to the seed.

Germination maximums were obtained by a short 1-month stratification followed by a 20°C germination temperature. Longer stratification or warmer stratification did not reduce germination to a great extent; however, a 10°C germination temperature did.

Without stratification, germination improved with seed age and for older seed in particular was not very much below the level reached by stratification. Again, 20°C was the optimum germination temperature.

Planting rubber rabbitbrush seed is apparently satisfactory any time after seed harvest up to at least the second fall.

Chrysothamnus nauseosus

PHENOLOGY

1. Ripe Seed Period	September 25 - November 20+
2. Optimum Collection Period	October 4 - November 8
3. Peak Ripe Seed	October 8
4. 50% Seed Shatter	November 8

COLLECTION

5. Methods	Seed knocked off plant with flail into large container

CLEANING

6. Procedure	Mechanical flail Clipper (1/13)/blank Seed blower

7. Seed

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %	97	97
9. Seed Fill - Range	88-100	95-99
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		
SEED WEIGHT		
12. Grams Per Liter	504	422
13. Seed Per Gram	980	1063
14. Seed Per Pound		
SB	445,000	483,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	2 mo	1 mo/4°wet	20°	14	99	2
20° dry	2 mo	1 mo/4°wet	10°	14	36	7
20° dry	12 mo	--	20°	8	94 pls	4
20° dry	2 mo	--	20°	8	88 pls	5
20° dry	12 mo	--	30°	8	86 pls	3

CHRYSOTHAMNUS VICIDIFLORUS

Chrysothamnus vicidiflorus (Hook) Nutt. (green rabbitbrush) is a low to medium height (ours 2-4 dm tall) shrub of the Composite family. It was scattered throughout the dryer grasslands.

Flowering was complete by late September in 1976 and all seed had matured by mid-October. Seed began to mature in late August and loss to shatter began in early September. Flowering did not overlap seed shatter. An October 9th observation of 39 percent green seed, 49 percent ripe seed, and 12 percent loss to shatter is illustrative of the overlaps.

Collection was made difficult by the uneven ripening of seed; however, when the intact seed heads were flailed, the mature seed released well and were collected in a tarp or other container. Cleaning was difficult because of the large amount of chaff, 30-50 percent of material, which could not be removed by any process we employed.

Optimum germination was obtained from unstratified seed germinated at 20°C or above. Stratification did not reduce total germination. However, germination temperatures of 10°C or 20-5°C did not reduce germination very much unless preceded by at least 3 months of stratification.

Green rabbitbrush apparently can be planted anytime after harvest through the second fall and large percentage germination should result.

Chrysothamnus vicidiflorus

PHENOLOGY

1. Ripe Seed Period	August 26 - November 20+
2. Optimum Collection Period	October 3 - November 7
3. Peak Ripe Seed	October 22
4. 50% Seed Shatter	November 7

COLLECTION

5. Methods	Seed knocked off plant with flail into large container

CLEANING

6. Procedure	Mechanical flail Clipper (1/13)/blank Seed blower

7. Seed

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %	94	98
9. Seed Fill - Range	86-99	96-100
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		
SEED WEIGHT		
12. Grams Per Liter	432	413
13. Seed Per Gram	1350	1224
14. Seed Per Pound		
SB	613,000	556,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	12 mo	--	20°	8	97 pls	2
20° dry	12 mo	--	30°	8	92 pls	2
20° dry	12 mo	--	10°	8	40 pls	9
20° dry	2 mo	--	30°	8	97 pls	3
20° dry	2 mo	3 mo/4°wet	30°	14	97	1

SARCOBATUS VERMICULATUS

Sarcobatus vermiculatus (Hook) Torr. (greasewood) is a medium-to-tall (ours 1 to 2.5 m), brittle, spiny shrub of the Goosefoot family found on alkaline soils with a high water table.

Collection was by knocking the mature seed from plants into a tarp or other container. Not all seed ripen at the same time and dispersal was a slow process over winter.

The cleaning process required mechanical abrasion to remove wings; however, when the seeds were well dried, it was a rapid process.

Germination was favored by 20°C temperatures on unstratified seed and by 30°C temperatures following stratification on new seed. Germination was much reduced at 10°C or 20-5°C temperatures.

Older seed tended to decline in germinability unless they were stratified for 2 to 3 months. Seed also increased in ability to germinate at 4°C and 10°C with age. For example, seed less than a month old reached 6 percent germination and 12-month old seed reached 77 percent germination under 10°C dark conditions.

Spring planting the year after collection would appear to favor germination although planting the second fall would be a possible close second.

Sarcobatus vermiculatus

PHENOLOGY

1. Ripe Seed Period
2. Optimum Collection Period — (Late Sept - Mid-Nov 75-76)
3. Peak Ripe Seed
4. 50% Seed Shatter

COLLECTION

5. Methods — Seeds knocked from plants with flail

CLEANING

6. Procedure — Mechanical flail
Clipper 8/(1/25)
Seed blower

7. Seed

SEED FILL-PRODUCTION	1975	1976
8. Seed Fill - %	82	38
9. Seed Fill - Range	70-94	7-98
10. Filled Seed Per Plant		
11. Filled Seed Per Inflorescence		
SEED WEIGHT		
12. Grams Per Liter	686	438
13. Seed Per Gram	425	566
14. Seed Per Pound		
SB	193,000	257,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	1 mo	--	20°	14	72	6
20° dry	6 mo	3 mo/4°wet	20-05°	14	67	1
20° dry	12 mo	--	10°	8	61	3
20° dry	12 mo	--	20°	8	55	2
20° dry	12 mo	--	30°	8	60	2

YUCCA GLAUCA

Yucca glauca Nutt. (soap-weed) is a stout, clumped, erect (ours 6-10 dm tall), woody-based plant of the Lily family. It was found locally abundant on very coarse textured soils.

Seed was available by mid-October through the early spring of the next year. However, since insect damage appears progressive from green seed formation on, fall collections are best. Collections were made by knocking seed from intact dehiscent capsules and by collection of entire capsules, drying and knocking the seed out.

Germination at 20°C after 1, 2, or 3 months stratification, germination at 20-5°C after 1 to 3 months stratification, and germination at 20°C after cold 4°C dry storage provided the highest germination.

Germination, at 30°C or 30-20°C, was reduced to a maximum of 27 percent whether stratified or not, while 10°C was an effective germination temperature. In the latter case, seeds reached 67 percent germination after 3-month stratification.

Immediate fall planting or storage at 4°C dry over winter and early spring planting are indicated for soap-weed.

Yucca glauca

PHENOLOGY

1. Ripe Seed Period
2. Optimum Collection Period — (Mid-Sept - Mid-Oct 75-76)
3. Peak Ripe Seed
4. 50% Seed Shatter

COLLECTION

5. Methods — Hand-picked

CLEANING

6. Procedure — Seed removed by hand from dehiscent capsules
Seed blower

7. Seed

SEED FILL-PRODUCTION		1975	1976
8. Seed Fill - %		89	88
9. Seed Fill - Range		82-95	82-93
10. Filled Seed Per Plant			
11. Filled Seed Per Inflorescence			
SEED WEIGHT			
12. Grams Per Liter		227	232
13. Seed Per Gram		57	62
14. Seed Per Pound	100% PLS	27,000	
	SB	26,000	28,000

GERMINATION

Storage	Seed Age	Seed Treat.	Temp.	Light	Germ.%	Days to 50% Germ.
20° dry	4 mo	3 mo/4°wet	20°	14	91	6
20° dry	4 mo	1 mo/4°wet	20°	14	83	10
20° dry	8 mo	3 mo/4°wet	20-05°	14	74	4
20° dry	10 mo	3 mo/4°wet	30-20°	14	18	8
20° dry	10 mo	--	20-05°	14	41	18